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EMC Test Report

Application for Grant of Equipment Authorization

FCC Part 15 Subpart C

Models: TCD849500, TCD849000 and TCD849510

FCC ID:	TGN-TCD8495
APPLICANT:	Tivo Inc. 2160 Gold St. Alviso, CA 95002
TEST SITE(S):	National Technical Systems - Silicon Valley 41039 Boyce Road. Fremont, CA. 94538-2435
IC SITE REGISTRATION #:	2845B-3, 2845B-4
REPORT DATE:	July 29, 2015
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Testing Cert #0214.26

REVISION HISTORY

Rev#	Date	Comments	Modified By
-	July 29, 2015	First release	
1	August 3, 2015	Replaced emissions test data below 1 GHz and revised test results summary on page 6	dwb

TABLE OF CONTENTS

SCOPE

An electromagnetic emissions test has been performed on the Tivo Inc. model TCD849500, TCD849000 and TCD849510, pursuant to the following rules:

FCC Part 15 Subpart C

Conducted and radiated emissions data has been collected, reduced, and analyzed within this report in accordance with measurement guidelines set forth in the following reference standards and as outlined in National Technical Systems - Silicon Valley test procedures:

ANSI C63.10-2009
FCC DTS Measurement Guidance KDB558074

The intentional radiator above has been tested in a simulated typical installation to demonstrate compliance with the relevant Industry Canada performance and procedural standards.

Final system data was gathered in a mode that tended to maximize emissions by varying orientation of EUT, orientation of power and I/O cabling, antenna search height, and antenna polarization.

Every practical effort was made to perform an impartial test using appropriate test equipment of known calibration. All pertinent factors have been applied to reach the determination of compliance.

OBJECTIVE

The primary objective of the manufacturer is compliance with the regulations outlined in the previous section.

Prior to marketing in the USA, all unlicensed transmitters and transceivers require certification. Receive-only devices operating between 30 MHz and 960 MHz are subject to either certification or a manufacturer's declaration of conformity, with all other receive-only devices exempt from the technical requirements.

Prior to marketing in Canada, Class I transmitters, receivers and transceivers require certification. Class II devices are required to meet the appropriate technical requirements but are exempt from certification requirements.

Certification is a procedure where the manufacturer submits test data and technical information to a certification body and receives a certificate or grant of equipment authorization upon successful completion of the certification body's review of the submitted documents. Once the equipment authorization has been obtained, the label indicating compliance must be attached to all identical units, which are subsequently manufactured.

Maintenance of compliance is the responsibility of the manufacturer. Any modification of the product which may result in increased emissions should be checked to ensure compliance has been maintained (i.e., printed circuit board layout changes, different line filter, different power supply, harnessing or I/O cable changes, etc.).

STATEMENT OF COMPLIANCE

The tested sample of Tivo Inc. model TCD849500 complied with the requirements of the following regulations:

FCC Part 15 Subpart C

Maintenance of compliance is the responsibility of the manufacturer. Any modifications to the product should be assessed to determine their potential impact on the compliance status of the device with respect to the standards detailed in this test report.

The test results recorded herein are based on a single type test of Tivo Inc. model TCD849500 and therefore apply only to the tested sample. The sample was selected and prepared by Jim Inokuchi of Tivo Inc.

DEVIATIONS FROM THE STANDARDS

No deviations were made from the published requirements listed in the scope of this report.

TEST RESULTS SUMMARY

DIGITAL TRANSMISSION SYSTEMS (2400 – 2483.5MHz)

FCC Rule Part		Description	Measured Value / Comments	Limit / Requirement	Result
15.247(a)		Digital Modulation	Systems uses digital modulation techniques	System must utilize a digital transmission technology	Complies
15.247 (a) (2)		6dB Bandwidth	1.58 MHz	>500kHz	Complies
15.247 (b) (3)		Output Power (multipoint systems)	-9.8 dBm (0.0001 Watts) EIRP = 0.0002 W Note 1	1Watt, EIRP limited to 4 Watts.	Complies
15.247(d)		Power Spectral Density	-14.1 dBm/100kHz	8dBm/3kHz	Complies
15.247(c)		Antenna Port Spurious Emissions 30MHz – 25 GHz		< -30dBc Note 2	Complies
15.247(c) / 15.209		Radiated Spurious Emissions 30MHz – 25 GHz	39.8 dBµV/m @ 192.00 MHz (-3.7 dB)	15.207 in restricted bands, all others <-30dBc Note 2	Complies
Note 1: EIRP calculated using antenna gain of 2.7 dBi for the highest EIRP system. Note 2: Limit of -30dBc used because the power was measured using the UNII test procedure (maximum power averaged over a transmission burst).					

GENERAL REQUIREMENTS APPLICABLE TO ALL BANDS

FCC Rule Part		Description	Measured Value / Comments	Limit / Requirement	Result (margin)
15.203		RF Connector	Integral Antenna	Unique or integral antenna required	Complies
15.207		AC Conducted Emissions	55.8 dBµV @ 0.154 MHz (-10.0 dB)	Refer to page 18	Complies
15.247 (b) (5) 15.407 (f)		RF Exposure Requirements	Refer to MPE calculations in separate exhibit, RSS 102 declaration and User Manual statements.	Refer to OET 65, FCC Part 1 and RSS 102	Complies
		Occupied Bandwidth	2.7 MHz	Information only	N/A

MEASUREMENT UNCERTAINTIES

ISO/IEC 17025 requires that an estimate of the measurement uncertainties associated with the emissions test results be included in the report. The measurement uncertainties given below are based on a 95% confidence level and were calculated in accordance with UKAS document LAB 34.

Measurement Type	Measurement Unit	Frequency Range	Expanded Uncertainty
RF power, conducted (power meter)	dBm	25 to 7000 MHz	± 0.52 dB
RF power, conducted (Spectrum analyzer)	dBm	25 to 7000 MHz	± 0.7 dB
Conducted emission of transmitter	dBm	25 to 26500 MHz	± 0.7 dB
Conducted emission of receiver	dBm	25 to 26500 MHz	± 0.7 dB
Radiated emission (substitution method)	dBm	25 to 26500 MHz	± 2.5 dB
Radiated emission (field strength)	dBµV/m	25 to 1000 MHz	± 3.6 dB
		1000 to 40000 MHz	± 6.0 dB
Conducted Emissions (AC Power)	dBµV	0.15 to 30 MHz	± 2.4 dB

EQUIPMENT UNDER TEST (EUT) DETAILS

GENERAL

The Tivo Inc. models TCD849500, TCD849000 and TCD849510 are Digital Video Recorders that are designed to record and deliver TV and other content from a cable system to a TV. It incorporates a Certified Wi-Fi/BT radio module and RF4CE radio. Since the EUT could be placed in many positions during operation, the EUT was treated as tabletop equipment during testing to simulate the end-user environment. The electrical rating of the EUT is 120 Volts, 60 Hz, 1 Amp. The difference between models is the capacity of the disk drive and if a cable card is required.

The sample was received on June 10, 2015 and tested on June 10, 12 and 17, 2015. The EUT consisted of the following component(s):

Company	Model	Description	Serial Number	FCC ID
Tivo	TCD849500	Digital Video Recorder	8491xxxxx	TGN-TCD8495
Tivo	NBS40C120300VU	AC Adapter	-	-

ANTENNA SYSTEM

The antenna system consists of PCB trace antennas. Antenna gains are:
RF4CE is 2.7 dBi
BT antenna peak gain is 2.7 dBi (Modular approval for 4.7 dBi)
Wi-Fi antenna 1: 3.3 @2.4GHz, 1.7 5GHz (Modular approved for 4 dBi@2.4 GHz and 7.7 dBi@5 GHz)
Wi-Fi antenna 2: 3.6 @2.4 GHz, 3.1 5GHz (Modular approved for 4 dBi@2.4 GHz and 7.7 dBi@5 GHz)

ENCLOSURE

The EUT enclosure is primarily constructed of plastic. It measures approximately 28.7 cm wide by 17.5 cm deep by 4.5 cm high.

MODIFICATIONS

No modifications were made to the EUT during the time the product was at NTS Silicon Valley.

SUPPORT EQUIPMENT

The following equipment was used as support equipment for testing:

Company	Model	Description	Serial Number	FCC ID
Vizio	VX200E	TV	LSMFBAK2001522	DoC
Microsoft	1405	Mouse	0204609381409	-
PNY	32G	Thumb Drive	-	-
Beats	-	Head Phones	-	-

The following equipment was used as remote support equipment for emissions testing:

Company	Model	Description	Serial Number	FCC ID
Asus	R503U	Laptop	CBNOCX177B46462	-
Cisco	E3200	Router	10B10C109555	-
DekTec	DTU-215	RF generator/modulator	4215.001.109	-

EUT INTERFACE PORTS

The I/O cabling configuration during testing was as follows:

Port	Connected To	Cable(s)		
		Description	Shielded or Unshielded	Length(m)
Ethernet	Remote Router	Cat 5	Unshielded	8
HDMI	TV	Multiwire	Shielded	1
RF in	Remote Modulator	Coax	Shielded	8
DC Power	AC/DC Convertor	2 Wire	Unshielded	1
USB	Tumb Drive	Multiwire	Shielded	
USB	Mouse	Multiwire	Shielded	1
Audio	Headphones	2 Wire	unshielded	1
SATA	unterminated	-	-	-

EUT OPERATION

During testing, the EUT was configured to transmit continuously with 100% duty cycle on each of the three RF4CE channels as the maximum power level as required.

TEST SITE

GENERAL INFORMATION

Final test measurements were taken at the test sites listed below. Pursuant to section 2.948 of the FCC's Rules and section 3.3 of RSP-100, construction, calibration, and equipment data has been filed with the Commission and with industry Canada.

Site	Designation / Registration Numbers		Location
	FCC	Canada	
Chamber 3	US0027	2845B-3	41039 Boyce Road Fremont, CA 94538-2435
Chamber 4	US0027	2845B-4	

ANSI C63.4 recommends that ambient noise at the test site be at least 6 dB below the allowable limits. Ambient levels are below this requirement. The test site(s) contain separate areas for radiated and conducted emissions testing. Considerable engineering effort has been expended to ensure that the facilities conform to all pertinent requirements of ANSI C63.4.

CONDUCTED EMISSIONS CONSIDERATIONS

Conducted emissions testing is performed in conformance with ANSI C63.10. Measurements are made with the EUT connected to the public power network through a nominal, standardized RF impedance, which is provided by a line impedance stabilization network, known as a LISN. A LISN is inserted in series with each current-carrying conductor in the EUT power cord.

RADIATED EMISSIONS CONSIDERATIONS

The FCC has determined that radiation measurements made in a shielded enclosure are not suitable for determining levels of radiated emissions. Radiated measurements are performed in an open field environment or in a semi-anechoic chamber. The test sites are maintained free of conductive objects within the CISPR defined elliptical area incorporated in ANSI C63.4 guidelines and meet the Normalized Site Attenuation (NSA) requirements of ANSI C63.4.

MEASUREMENT INSTRUMENTATION

RECEIVER SYSTEM

An EMI receiver as specified in CISPR 16-1-1 is used for emissions measurements. The receivers used can measure over the frequency range of 9 kHz up to 2000 MHz. These receivers allow both ease of measurement and high accuracy to be achieved. The receivers have Peak, Average, and CISPR (Quasi-peak) detectors built into their design so no external adapters are necessary. The receiver automatically sets the required bandwidth for the CISPR detector used during measurements. If the repetition frequency of the signal being measured is below 20Hz, peak measurements are made in lieu of Quasi-Peak measurements.

For measurements above the frequency range of the receivers, a spectrum analyzer is utilized because it provides visibility of the entire spectrum along with the precision and versatility required to support engineering analysis. Average measurements above 1000MHz are performed on the spectrum analyzer using the linear-average method with a resolution bandwidth of 1 MHz and a video bandwidth of 10 Hz, unless the signal is pulsed in which case the average (or video) bandwidth of the measuring instrument is reduced to onset of pulse desensitization and then increased.

INSTRUMENT CONTROL COMPUTER

The receivers utilize either a Rohde & Schwarz EZM Spectrum Monitor/Controller or contain an internal Spectrum Monitor/Controller to view and convert the receiver measurements to the field strength at an antenna or voltage developed at the LISN measurement port, which is then compared directly with the appropriate specification limit. This provides faster, more accurate readings by performing the conversions described under Sample Calculations within the Test Procedures section of this report. Results are printed in a graphic and/or tabular format, as appropriate. A personal computer is used to record all measurements made with the receivers.

The Spectrum Monitor provides a visual display of the signal being measured. In addition, the controller or a personal computer run automated data collection programs which control the receivers. This provides added accuracy since all site correction factors, such as cable loss and antenna factors are added automatically.

LINE IMPEDANCE STABILIZATION NETWORK (LISN)

Line conducted measurements utilize a fifty microhenry Line Impedance Stabilization Network as the monitoring point. The LISN used also contains a 250 uH CISPR adapter. This network provides for calibrated radio frequency noise measurements by the design of the internal low pass and high pass filters on the EUT and measurement ports, respectively.

FILTERS/ATTENUATORS

External filters and precision attenuators are often connected between the receiving antenna or LISN and the receiver. This eliminates saturation effects and non-linear operation due to high amplitude transient events.

ANTENNAS

A loop antenna is used below 30 MHz. For the measurement range 30 MHz to 1000 MHz either a combination of a biconical antenna and a log periodic or a bi-log antenna is used. Above 1000 MHz, horn antennas are used. The antenna calibration factors to convert the received voltage to an electric field strength are included with appropriate cable loss and amplifier gain factors to determine an overall site factor, which is then programmed into the test receivers or incorporated into the test software.

ANTENNA MAST AND EQUIPMENT TURNTABLE

The antennas used to measure the radiated electric field strength are mounted on a non-conductive antenna mast equipped with a motor-drive to vary the antenna height. Measurements below 30 MHz are made with the loop antenna at a fixed height of 1m above the ground plane.

ANSI C63.10 specifies that the test height above ground for table mounted devices shall be 80 centimeters. Floor mounted equipment shall be placed on the ground plane if the device is normally used on a conductive floor or separated from the ground plane by insulating material from 3 to 12 mm if the device is normally used on a non-conductive floor as specified in ANSI C63.4. During radiated measurements, the EUT is positioned on a motorized turntable in conformance with this requirement.

INSTRUMENT CALIBRATION

All test equipment is regularly checked to ensure that performance is maintained in accordance with the manufacturer's specifications. All antennas are calibrated at regular intervals with respect to tuned half-wave dipoles. An exhibit of this report contains the list of test equipment used and calibration information.

TEST PROCEDURES

EUT AND CABLE PLACEMENT

The regulations require that interconnecting cables be connected to the available ports of the unit and that the placement of the unit and the attached cables simulate the worst case orientation that can be expected from a typical installation, so far as practicable. To this end, the position of the unit and associated cabling is varied within the guidelines of ANSI C63.10, and the worst-case orientation is used for final measurements.

CONDUCTED EMISSIONS

Conducted emissions are measured at the plug end of the power cord supplied with the EUT. Excess power cord length is wrapped in a bundle between 30 and 40 centimeters in length near the center of the cord. Preliminary measurements are made to determine the highest amplitude emission relative to the specification limit for all the modes of operation. Placement of system components and varying of cable positions are performed in each mode. A final peak mode scan is then performed in the position and mode for which the highest emission was noted on all current carrying conductors of the power cord.

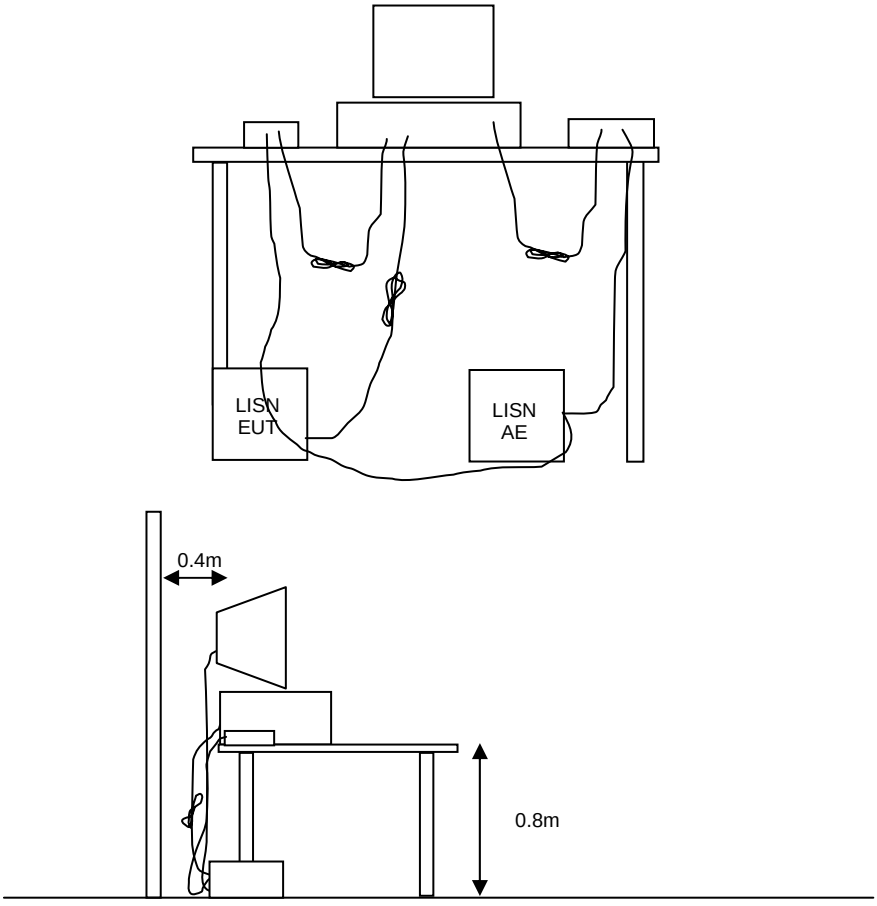


Figure 1 Typical Conducted Emissions Test Configuration

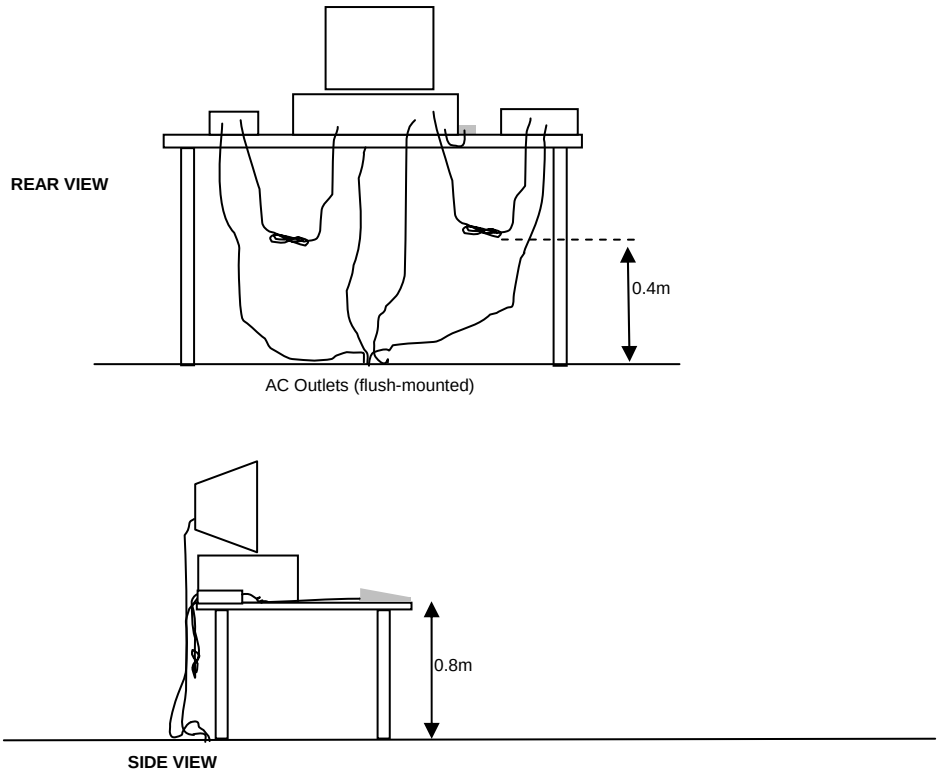
RADIATED EMISSIONS

A preliminary scan of the radiated emissions is performed in which all significant EUT frequencies are identified with the system in a nominal configuration. At least two scans are performed, one scan for each antenna polarization (horizontal and vertical; loop parallel and perpendicular to the EUT). During the preliminary scans, the EUT is rotated through 360˚, the antenna height is varied (for measurements above 30 MHz) and cable positions are varied to determine the highest emission relative to the limit. Preliminary scans may be performed in a fully anechoic chamber for the purposes of identifying the frequencies of the highest emissions from the EUT.

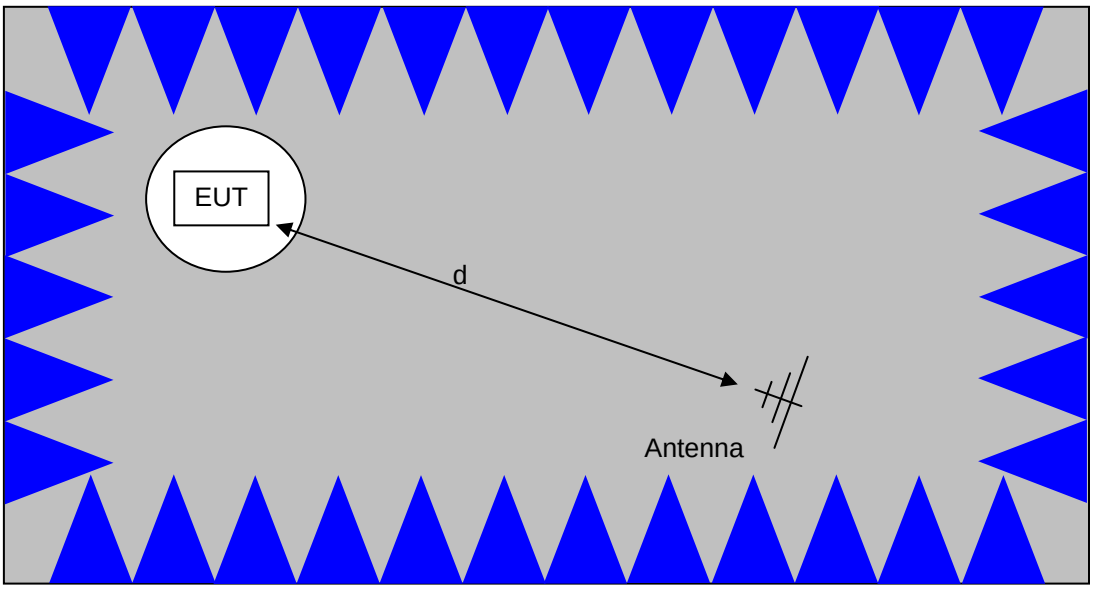
A speaker is provided in the receiver to aid in discriminating between EUT and ambient emissions. Other methods used during the preliminary scan for EUT emissions involve scanning with near field magnetic loops, monitoring I/O cables with RF current clamps, and cycling power to the EUT.

Final maximization is a phase in which the highest amplitude emissions identified in the spectral search are viewed while the EUT azimuth angle is varied from 0 to 360 degrees relative to the receiving antenna. The azimuth, which results in the highest emission is then maintained while varying the antenna height from one to four meters (for measurements above 30 MHz, measurements below 30 MHz are made with the loop antenna at a fixed height of 1m). The result is the identification of the highest amplitude for each of the highest peaks. Each recorded level is corrected in the receiver using appropriate factors for cables, connectors, antennas, and preamplifier gain.

When testing above 18 GHz, the receive antenna is located at 1meter from the EUT and the antenna height is restricted to a maximum of 2.5 meters.

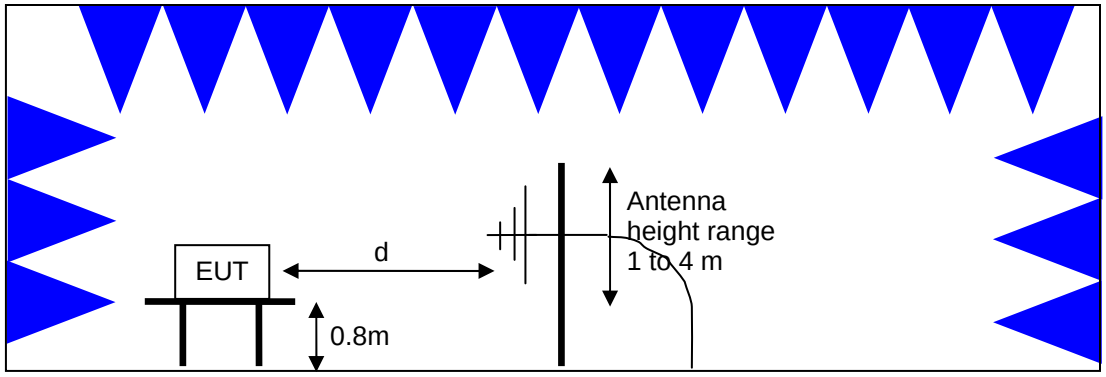


Typical Test Configuration for Radiated Field Strength Measurements



The anechoic materials on the walls and ceiling ensure compliance with the normalized site attenuation requirements of CISPR 16 / CISPR 22 / ANSI C63.4 for an alternate test site at the measurement distances used.

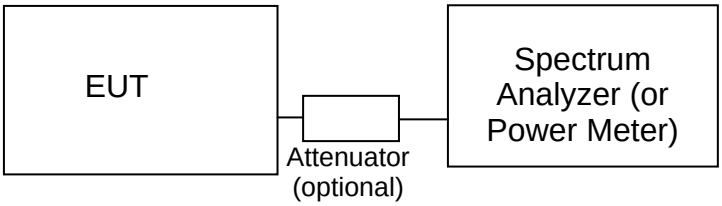
Floor-standing equipment is placed on the floor with insulating supports between the unit and the ground plane.



Test Configuration for Radiated Field Strength Measurements
Semi-Anechoic Chamber, Plan and Side Views

CONDUCTED EMISSIONS FROM ANTENNA PORT

Direct measurements of power, bandwidth and power spectral density are performed, where possible, with the antenna port of the EUT connected to either the power meter or spectrum analyzer via a suitable attenuator and/or filter. These are used to ensure that the front end of the measurement instrument is not overloaded by the fundamental transmission.



Test Configuration for Antenna Port Measurements

Measurement bandwidths (video and resolution) are set in accordance with the relevant standards and NTS Silicon Valley's test procedures for the type of radio being tested. When power measurements are made using a resolution bandwidth less than the signal bandwidth the power is calculated by summing the power across the signal bandwidth using either the analyzer channel power function or by capturing the trace data and calculating the power using software. In both cases the summed power is corrected to account for the equivalent noise bandwidth (ENBW) of the resolution bandwidth used.

If power averaging is used (typically for certain digital modulation techniques), the EUT is configured to transmit continuously. Power averaging is performed using either the built-in function of the analyzer or, if the analyzer does not feature power averaging, using external software. In both cases the average power is calculated over a number of sweeps (typically 100). When the EUT cannot be configured to continuously transmit then either the analyzer is configured to perform a gated sweep to ensure that the power is averaged over periods that the device is transmitting or power averaging is disabled and a max-hold feature is used.

If a power meter is used to make output power measurements the sensor head type (peak or average) is stated in the test data table.

BANDWIDTH MEASUREMENTS

The 6dB, 20dB, 26dB and/or 99% signal bandwidth are measured using the bandwidths recommended by ANSI C63.10 and RSS GEN.

SPECIFICATION LIMITS AND SAMPLE CALCULATIONS

The limits for conducted emissions are given in units of microvolts, and the limits for radiated emissions are given in units of microvolts per meter at a specified test distance. Data is measured in the logarithmic form of decibels relative to one microvolt, or dB microvolts (dBuV). For radiated emissions, the measured data is converted to the field strength at the antenna in dB microvolts per meter (dBuV/m). The results are then converted to the linear forms of uV and uV/m for comparison to published specifications.

For reference, converting the specification limits from linear to decibel form is accomplished by taking the base ten logarithm, then multiplying by 20. These limits in both linear and logarithmic form are as follows:

CONDUCTED EMISSIONS SPECIFICATION LIMITS: FCC 15.207; FCC 15.107(a), RSS GEN

The table below shows the limits for the emissions on the AC power line from an intentional radiator and a receiver.

Frequency (MHz)	Average Limit (dBuV)	Quasi Peak Limit (dBuV)
0.150 to 0.500	Linear decrease on logarithmic frequency axis between 56.0 and 46.0	Linear decrease on logarithmic frequency axis between 66.0 and 56.0
0.500 to 5.000	46.0	56.0
5.000 to 30.000	50.0	60.0

GENERAL TRANSMITTER RADIATED EMISSIONS SPECIFICATION LIMITS

The table below shows the limits for the spurious emissions from transmitters that fall in restricted bands[1], the limits for all emissions from a low power device operating under FCC Part 15 Subpart C section 15.209.

Frequency Range (MHz)	Limit (uV/m)	Limit (dBuV/m @ 3m)
0.009-0.490	$2400/F_{KHz}$ @ 300m	$67.6-20*\log_{10}(F_{KHz})$ @ 300m
0.490-1.705	$24000/F_{KHz}$ @ 30m	$87.6-20*\log_{10}(F_{KHz})$ @ 30m
1.705 to 30	30 @ 30m	29.5 @ 30m
30 to 88	100 @ 3m	40 @ 3m
88 to 216	150 @ 3m	43.5 @ 3m
216 to 960	200 @ 3m	46.0 @ 3m
Above 960	500 @ 3m	54.0 @ 3m

RECEIVER RADIATED SPURIOUS EMISSIONS SPECIFICATION LIMITS

The table below shows the limits for the spurious emissions from receivers as detailed in FCC Part 15.109. Note that receivers operating outside of the frequency range 30 MHz – 960 MHz are exempt from the requirements of 15.109.

Frequency Range (MHz)	Limit (uV/m @ 3m)	Limit (dBuV/m @ 3m)
30 to 88	100	40
88 to 216	150	43.5
216 to 960	200	46.0
Above 960	500	54.0

OUTPUT POWER LIMITS – DIGITAL TRANSMISSION SYSTEMS

The table below shows the limits for output power and output power density. Where the signal bandwidth is less than 20 MHz the maximum output power is reduced to the power spectral density limit plus 10 times the log of the bandwidth (in MHz).

Operating Frequency (MHz)	Output Power	Power Spectral Density
902 – 928	1 Watt (30 dBm)	8 dBm/3kHz
2400 – 2483.5	1 Watt (30 dBm)	8 dBm/3kHz
5725 – 5850	1 Watt (30 dBm)	8 dBm/3kHz

The maximum permitted output power is reduced by 1dB for every dB the antenna gain exceeds 6dBi. Fixed point-to-point applications using the 5725 – 5850 MHz band are not subject to this restriction.

[1] The restricted bands are detailed in FCC 15.205

TRANSMIT MODE SPURIOUS RADIATED EMISSIONS LIMITS – FHSS and DTS SYSTEMS

The limits for unwanted (spurious) emissions from the transmitter falling in the restricted bands are those specified in the general limits sections of FCC Part 15 and RSS 210. All other unwanted (spurious) emissions shall be at least 20dB below the level of the highest in-band signal level (30dB if the power is measured using the sample detector/power averaging method).

SAMPLE CALCULATIONS - CONDUCTED EMISSIONS

Receiver readings are compared directly to the conducted emissions specification limit (decibel form) as follows:

$$R_r - S = M$$

where:

R_r = Receiver Reading in dBuV

S = Specification Limit in dBuV

M = Margin to Specification in +/- dB

SAMPLE CALCULATIONS - RADIATED EMISSIONS

Receiver readings are compared directly to the specification limit (decibel form). The receiver internally corrects for cable loss, preamplifier gain, and antenna factor. The calculations are in the reverse direction of the actual signal flow, thus cable loss is added and the amplifier gain is subtracted. The Antenna Factor converts the voltage at the antenna coaxial connector to the field strength at the antenna elements.

A distance factor, when used for electric field measurements above 30MHz, is calculated by using the following formula:

$$F_d = 20*LOG_{10} (D_m/D_s)$$

where:

F_d = Distance Factor in dB

D_m = Measurement Distance in meters

D_s = Specification Distance in meters

For electric field measurements below 30MHz the extrapolation factor is either determined by making measurements at multiple distances or a theoretical value is calculated using the formula:

$$F_d = 40*LOG_{10} (D_m/D_s)$$

Measurement Distance is the distance at which the measurements were taken and Specification Distance is the distance at which the specification limits are based. The antenna factor converts the voltage at the antenna coaxial connector to the field strength at the antenna elements.

The margin of a given emission peak relative to the limit is calculated as follows:

$$R_c = R_r + F_d$$

and

$$M = R_c - L_s$$

where:

R_r = Receiver Reading in dBuV/m

F_d = Distance Factor in dB

R_c = Corrected Reading in dBuV/m

L_s = Specification Limit in dBuV/m

M = Margin in dB Relative to Spec

SAMPLE CALCULATIONS - FIELD STRENGTH TO EIRP CONVERSION

Where the radiated electric field strength is expressed in terms of the equivalent isotropic radiated power (eirp), or where a field strength measurement of output power is made in lieu of a direct measurement, the following formula is used to convert between eirp and field strength at a distance of d (meters) from the equipment under test:

$$E = \frac{1000000 \sqrt{30 P}}{d} \quad \text{microvolts per meter}$$

where P is the eirp (Watts)

For a measurement at 3m the conversion from a logarithmic value for field strength (dBuV/m) to an eirp power (dBm) is -95.3dB.

Appendix A Test Equipment Calibration Data

Manufacturer	Description	Model	Asset #	Calibrated	Cal Due
Radiated Emissions, 1000 - 26,000 MHz, 10-Jun-15					
EMCO	Antenna, Horn, 1-18 GHz	3115	487	7/29/2014	7/29/2016
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB7	1630	6/21/2014	6/21/2015
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	2199	2/20/2015	2/20/2016
Sunol Sciences	Biconilog, 30-3000 MHz	JB3	2237	8/29/2014	8/29/2016
Hewlett Packard	SpecAn 9 kHz - 40 GHz, (SA40) Purple	8564E (84125C)	2415	3/7/2015	3/7/2016
Com-Power	Preamplifier, 1-1000 MHz	PAM-103	2885	10/22/2014	10/22/2015
Conducted Emissions - AC Power Ports, 10-Jun-15					
EMCO	LISN, 10 kHz-100 MHz	3825/2	1293	6/2/2015	6/2/2016
Rohde & Schwarz	Pulse Limiter	ESH3 Z2	1401	5/14/2015	5/14/2016
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB7	1630	6/21/2014	6/21/2015
Com-Power	9KHz-30MHz, 50uH, 15Aac, 10Adc, max	LI-215A	2671	5/24/2014	6/22/2015
(BE Spurious Emissions), 10-Jun-15					
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB7	1630	6/21/2014	6/21/2015
EMCO	Antenna, Horn, 1-18 GHz	3115	2870	8/20/2013	8/20/2015
Radiated Emissions, 1000 - 3000 MHz, 12-Jun-15					
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB7	1630	6/21/2014	6/21/2015
EMCO	Antenna, Horn, 1-18 GHz	3115	2870	8/20/2013	8/20/2015
Radiated Emissions, 30 - 1,000 MHz, 17-Jun-15					
Sunol Sciences	Biconilog, 30-3000 MHz	JB3	1657	6/25/2014	6/25/2016
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB7	1756	6/14/2014	6/22/2015
Com-Power	Preamplifier, 30-1000 MHz	PA-103	2465	9/11/2014	9/11/2015

Appendix B Test Data

T98590 Pages 24 – 52

Client:	TiVo, Inc.	Job Number:	J98353
Product	Minos	T-Log Number:	T98590
System Configuration:	-	Project Manager:	Irene Rademacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Emissions Standard(s):	FCC Part 15B and C	Class:	B
Immunity Standard(s):	-	Environment:	Residential

EMC Test Data

For The

TiVo, Inc.

Product

Minos

Date of Last Test: 6/18/2015

Client:	TiVo, Inc.	Job Number:	J98353
Model:	Minos	T-Log Number:	T98590
		Project Manager:	Irene Rademacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15B and C	Class:	N/A

Power vs. Data Rate

In normal operating modes the card uses power settings stored on EEPROM to set the output power. For a given nominal output power the actual transmit power normally is reduced as the data rate increases, therefore testing was performed at the data rate in the mode with highest power to determine compliance with the requirements.
The following power measurements were made using a GATED average power meter and with the device configured in a continuous transmit mode on Chain 1 at the various data rates in each mode to verify the highest power mode:

Sample Notes

Sample S/N: P1-2 76/208
Driver:

Duty Cycle

Date of Test: 6/10/2051
Test Engineer: Joseph Cadigal
Test Location: FT Chamber#4

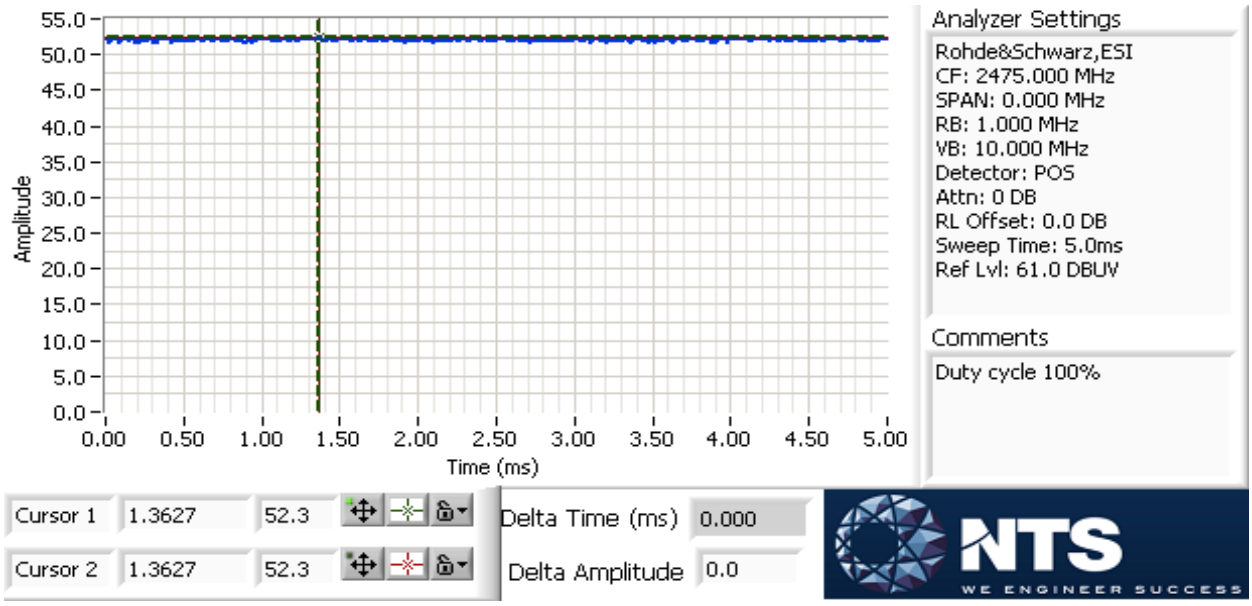
Duty cycle measurements performed on the worse case data rate for power.

Notes: Measurements taken with maximum RBW/VBW settings allowed.

Mode	Data Rate	Duty Cycle (x)	Constant DC?	T (ms)	Pwr Cor Factor*	Lin Volt Cor Factor**	Min VBW for FS (Hz)
RF4CE	-	1.00	Yes	100	0	0	10

* Correction factor when using RMS/Power averaging - 10*log(1/x)
** Correction factor when using linear voltage average - 20*log(1/x)
T = Minimum transmission duration

Client:	TiVo, Inc.	Job Number:	J98353
Model:	Minos	T-Log Number:	T98590
		Project Manager:	Irene Rademacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15B and C	Class:	N/A



Client:	TiVo, Inc.	Job Number:	J98353
Model:	Minos	T-Log Number:	T98590
		Project Manager:	Irene Rademacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15B and C	Class:	N/A

RSS 210 and FCC 15.247 (DTS) Measurements

Power, PSD, Bandwidth and Spurious Emissions

Test Specific Details

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

Date of Test: 6/12/2015
Test Engineer: John Caizzi/ R. Varelas
Test Location: Fremont Chamber #4

Config. Used: 1
Config Change: None
EUT Voltage: 120V/60Hz

General Test Configuration

The EUT and all local support equipment were located on the turntable for testing.
For testing the measurement antenna was located 3 meters from the EUT, unless otherwise noted.

Ambient Conditions:

Temperature: 22.5 °C
Rel. Humidity: 38 %

Summary of Results

Run #	Pwr setting		Test Performed	Limit	Pass / Fail	Result / Margin
1	Default		Output Power	15.247(b)	Pass	-9.8 dBm
2			Power spectral Density (PSD)	15.247(d)	Pass	-11.4 dBm/100kHz
3			Minimum 6dB Bandwidth	15.247(a)	Pass	1.58 MHz
3			99% Bandwidth	RSS GEN	-	2.7 MHz
4			Spurious emissions	15.247(b)	Pass	refer to plot

Modifications Made During Testing

No modifications were made to the EUT during testing

Deviations From The Standard

No deviations were made from the requirements of the standard.

Procedure Comments:

Measurements performed in accordance with FCC KDB 558074

Client:	TiVo, Inc.	Job Number:	J98353
Model:	Minos	T-Log Number:	T98590
		Project Manager:	Irene Rademacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15B and C	Class:	N/A

Mode	Data Rate	Duty Cycle (x)	Constant DC?	T (ms)	Pwr Cor Factor*	Lin Volt Cor Factor**	Min VBW for FS (Hz)
RF4CE	-	1.00	Yes	100	0	0	10

Sample Notes

Sample S/N:
Driver:

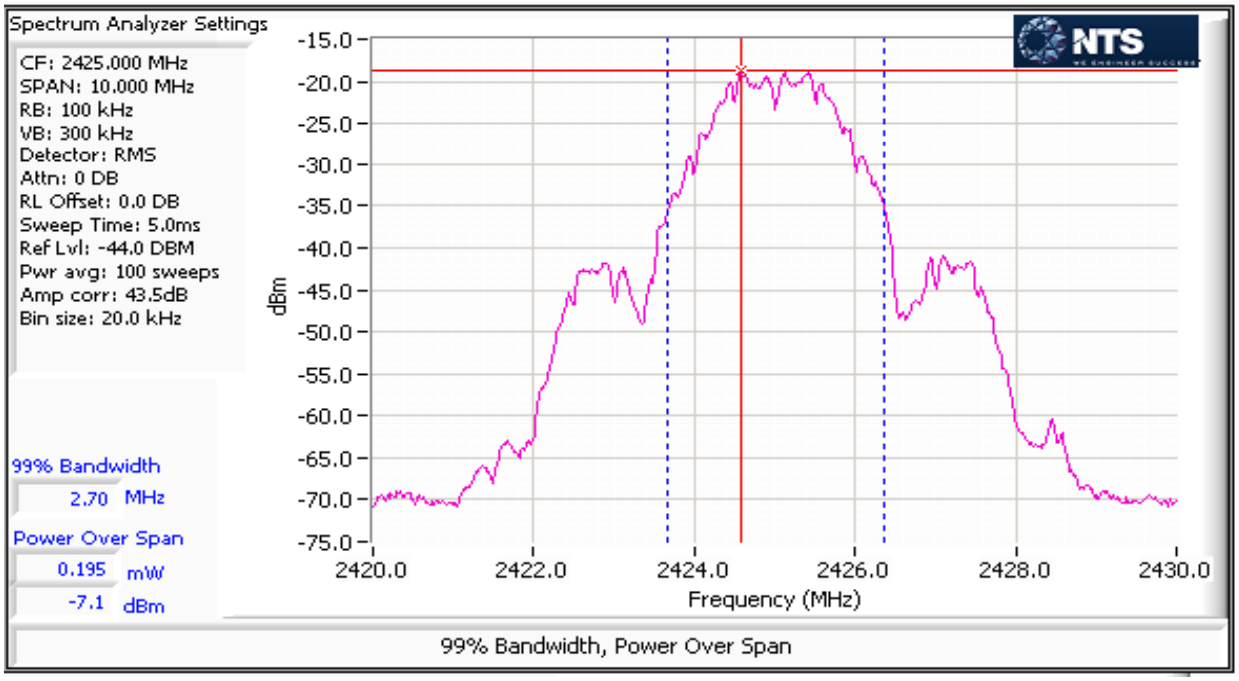
Client:	TiVo, Inc.	Job Number:	J98353
Model:	Minos	T-Log Number:	T98590
		Project Manager:	Irene Rademacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15B and C	Class:	N/A

Run #1: Output Power (measured EIRP)

Mode: RF4CE

Power Setting[2]	Frequency (MHz)	Output Power (dBm)[1]	Output Power mW	Antenna Gain (dBi)	Result	EIRP dBm	EIRP W	Fld Strength (dBuV/m) V	Fld Strength (dBuV/m) H
Default	2425	-9.8	0.1047	2.7	Pass	-7.1	0.000195	73.5	82.7
	2450	-9.8	0.1047	2.7	Pass	-7.1	0.000195	-	83.1
	2475	-11.5	0.0708	2.7	Pass	-8.8	0.000132	-	81.9

Note 1:	Duty Cycle ≥ 98%. Output EIRP measured using a spectrum analyzer (see plots below) with RBW= 1-5% of OBW, VB≥3* RBW, RMS detector, power averaging on, and power integration over the OBW, trace average 100 traces (option AVGSA-1, in KDB 558074). Spurious limit becomes -30dBc.
Note 2:	Power setting - the software power setting used during testing, included for reference only.
Note 3:	This measurement determines the antenna polarization with the higher output level.



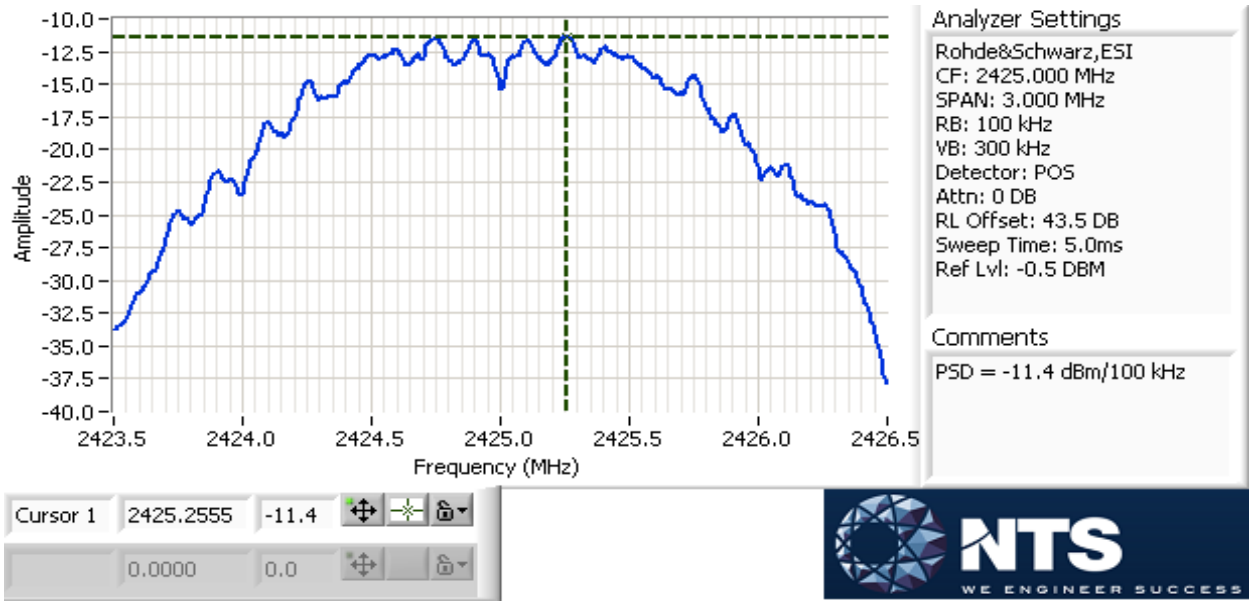
Client:	TiVo, Inc.	Job Number:	J98353
Model:	Minos	T-Log Number:	T98590
		Project Manager:	Irene Rademacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15B and C	Class:	N/A

Run #2: Power Spectral Density (Measured EIRP)

Mode: RF4CE

Power Setting	Frequency (MHz)	PSD (dBm/100Hz) Note 1	Limit dBm/3kHz	Result
Default	2425	-14.1	8.0	Pass
	2450	-14.2	8.0	Pass
	2475	-15.7	8.0	Pass

Note 1:	Test performed per method PKSPD, in KDB 558074. Power spectral density measured using: 3kHz ≤ RBW ≤ 100kHz, VBW=3*RBW, peak detector, span = 1.5*DTS BW, auto sweep time, max hold.
Note 2:	Measured EIRP and calculated PSD.



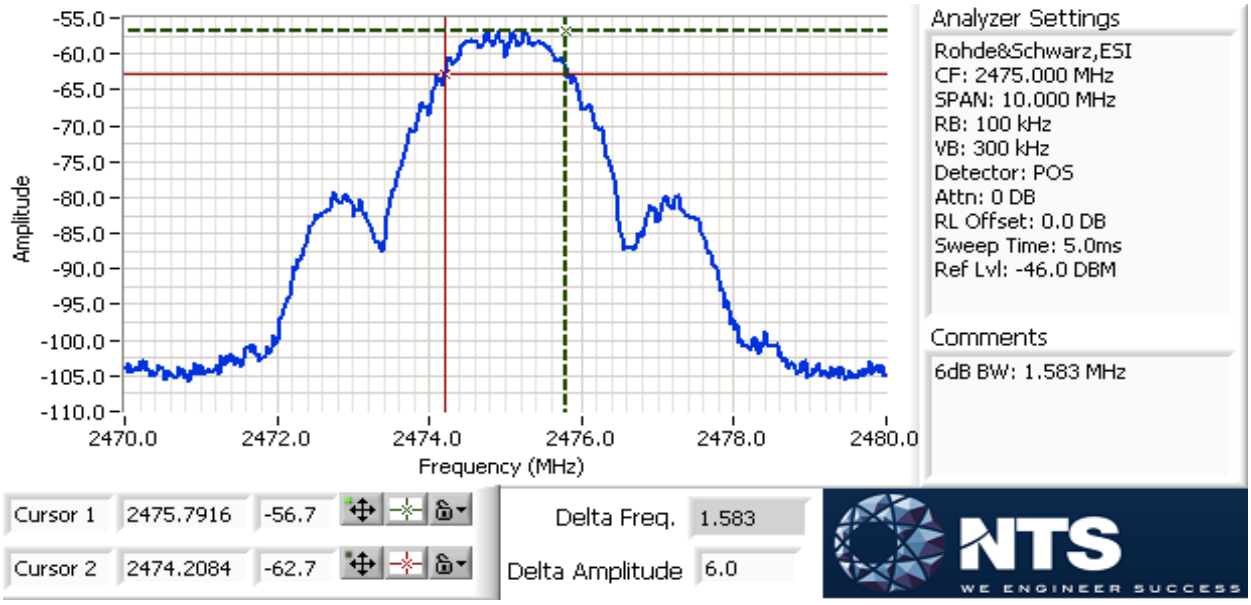
Client:	TiVo, Inc.	Job Number:	J98353
Model:	Minos	T-Log Number:	T98590
		Project Manager:	Irene Rademacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15B and C	Class:	N/A

Run #3: Signal Bandwidth

Mode: RF4CE

Power Setting	Frequency (MHz)	Bandwidth (MHz)		RBW Setting (kHz)	
		6dB	99%	6dB	99%
Default	2425	1.60	2.70	100	100
	2450	1.60	2.66	100	100
	2475	1.58	2.64	100	100

Note 1:	DTS BW: RBW=100kHz, VBW ≥ 3*RBW, peak detector, max hold, auto sweep time. 99% BW: RBW=1-5% of 99%BW, VBW ≥ 3*RBW, peak detector, max hold, auto sweep time.

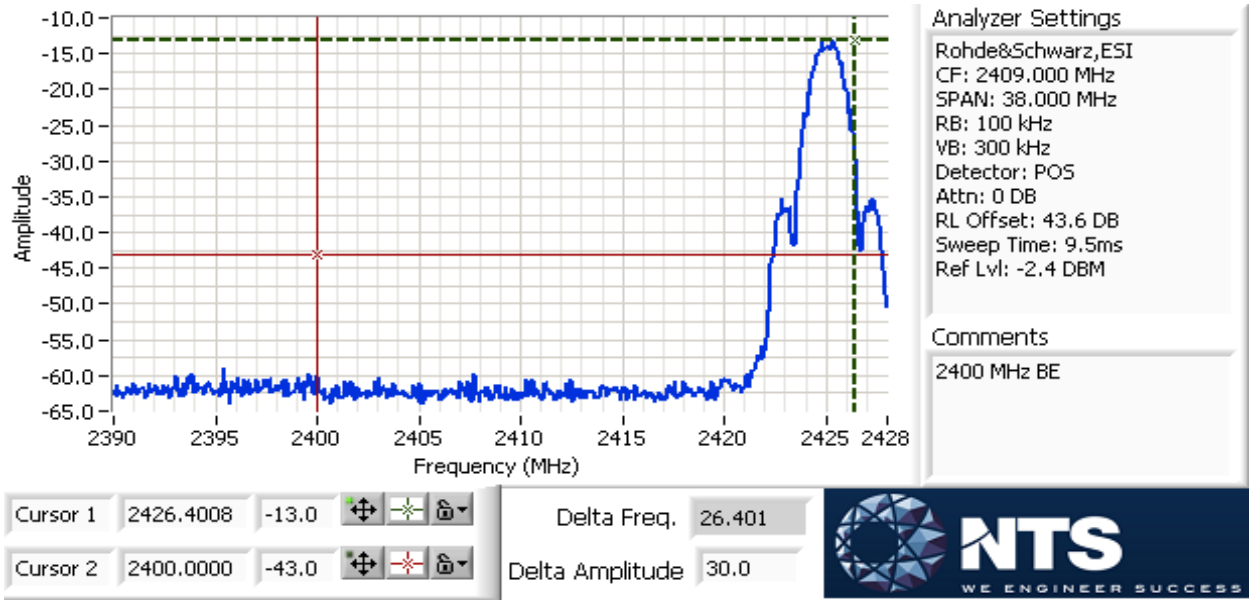


Client:	TiVo, Inc.	Job Number:	J98353
Model:	Minos	T-Log Number:	T98590
		Project Manager:	Irene Rademacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15B and C	Class:	N/A

Run #4a: Out of Band Spurious Emissions

Frequency (MHz)	Power Setting	Mode	Limit	Result
2425	Default	RF4CE	-30dBc	Pass

Plots for low channel



Plot from radiated measurement showing compliance with -30dBc limit from 2390 MHz to 2400 MHz. Radiated measurements used to show compliance with the unwanted emissions limits from 30 MHz - 25 GHz.

Client:	TiVo, Inc.	Job Number:	J98353
Model:	Minos	T-Log Number:	T98590
		Project Manager:	Irene Rademacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15B and C	Class:	N/A

RSS 210 and FCC 15.247 (DTS) Radiated Spurious Emissions

Test Specific Details

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

General Test Configuration

The EUT and all local support equipment were located on the turntable for radiated spurious emissions testing.
For radiated emissions testing the measurement antenna was located 3 meters from the EUT, unless otherwise noted.

Ambient Conditions:

Temperature: 25 °C
Rel. Humidity: 31 %

Summary of Results - Device Operating in the 2400-2483.5 MHz Band

Run #	Mode	Channel	Power Setting	Measured Power	Test Performed	Limit	Result / Margin
1a	RF4CE	low - 2425MHz	Default	-	Radiated Emissions, 1 - 26 GHz	FCC Part 15.209 / 15.247(c)	47.8 dBµV/m @ 7500.1 MHz (-6.2 dB)
1b	RF4CE	center - 2450MHz	Default	-	Radiated Emissions, 1 - 26 GHz	FCC Part 15.209 / 15.247(c)	46.3 dBµV/m @ 7500.1 MHz (-7.7 dB)
1c	RF4CE	high- 2475MHz	Default	-	Radiated Emissions, 1 - 26 GHz	FCC Part 15.209 / 15.247(c)	46.6 dBµV/m @ 7500.1 MHz (-7.4 dB)

Modifications Made During Testing

No modifications were made to the EUT during testing

Deviations From The Standard

No deviations were made from the requirements of the standard.

Procedure Comments:

Measurements performed in accordance with FCC KDB 558074
Peak measurements performed with: RBW=1MHz, VBW=3MHz, peak detector, max hold, auto sweep time
Unless otherwise stated/noted, emission has duty cycle ≥ 98% and was measured using RBW=1MHz, VBW=10Hz, peak detector, linear average mode, auto sweep time, max hold.

Client:	TiVo, Inc.	Job Number:	J98353
Model:	Minos	T-Log Number:	T98590
		Project Manager:	Irene Rademacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15B and C	Class:	N/A

Mode	Data Rate	Duty Cycle (x)	Constant DC?	T (ms)	Pwr Cor Factor*	Lin Volt Cor Factor**	Min VBW for FS (Hz)
RF4CE	-	1.00	Yes	100	0	0	10

Sample Notes

Sample S/N: P1-2 76/208

Measurement Specific Notes:

Note 1:	Emission in non-restricted band, but limit of 15.209 used.
Note 2:	Emission in non-restricted band, the limit was set 30dB below the level of the fundamental and measured in 100kHz.
Note 2:	Emission has duty cycle ≥ 98%, average measurement performed: RBW=1MHz, VBW=3MHz, RMS, Power averaging, auto sweep, trace average 100 traces
Note 3:	Emission has duty cycle < 98%, but constant, average measurement performed: RBW=1MHz, VBW=10Hz, peak detector, linear averaging, auto sweep, trace average 100 traces, measurement corrected by Linear Voltage correction factor
Note 4:	Emission has duty cycle < 98% and is NOT constant, average measurement performed: RBW=1MHz, VBW> 1/T, peak detector, linear average mode, sweep time auto, max hold. Max hold for 50*(1/DC) traces
Note 5:	Emission has duty cycle < 98%, but constant, average measurement performed: RBW=1MHz, VBW=3MHz, RMS, Power averaging, auto sweep, trace average 100 traces, measurement corrected by Pwr correction factor
Note 6:	Plots of the average and peak bandedge do not account for any duty cycle correction. Refer to the tabular results for final measurements.

Client:	TiVo, Inc.	Job Number:	J98353
Model:	Minos	T-Log Number:	T98590
		Project Manager:	Irene Rademacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15B and C	Class:	N/A

Run #1: Radiated Spurious Emissions, 1000 - 26000 MHz. Operating Mode: 802.11b

Date of Test: 6/10/2015 0:00 Config. Used: 1

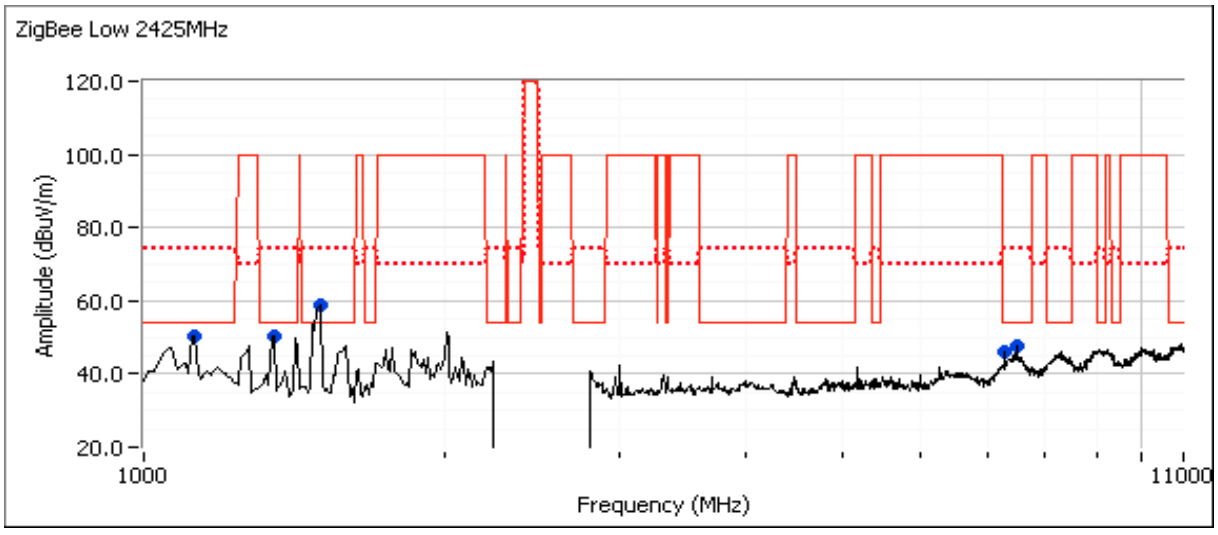
Test Engineer: Joseph Cadigal Config Change: none

Test Location: FT Chamber#4 EUT Voltage: 120V/60Hz

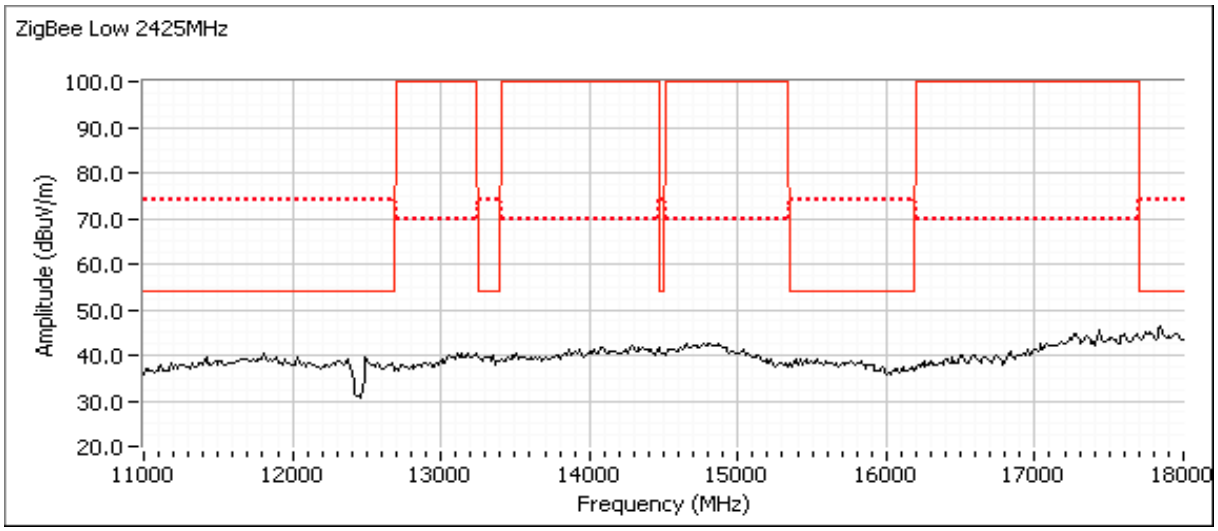
Run #1a: Low Channel @ 2425 MHz

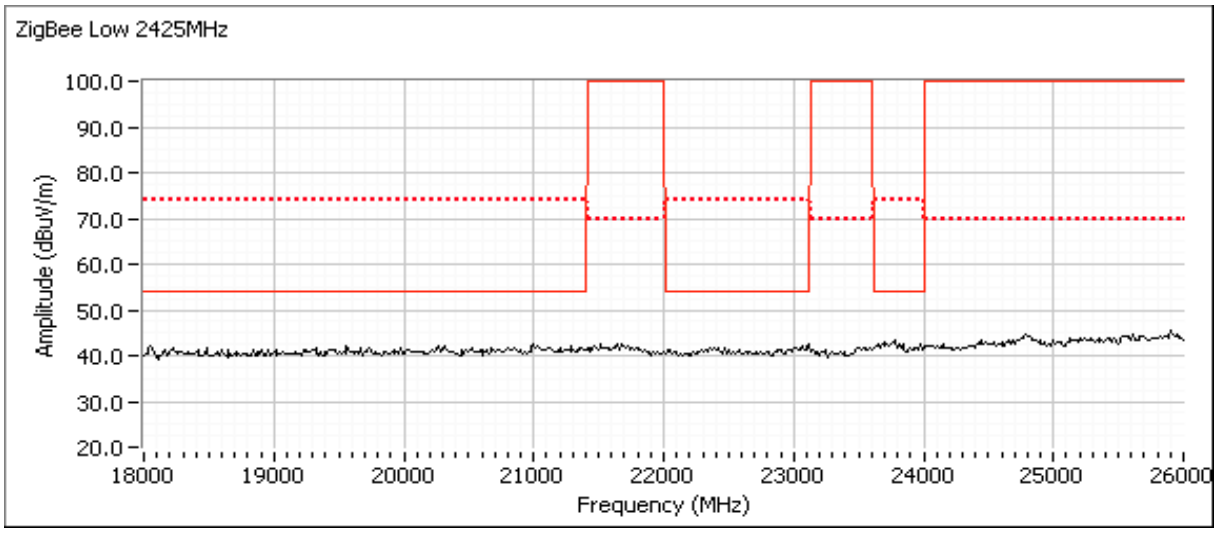
Other Spurious Emissions

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
7500.130	47.8	V	54.0	-6.2	AVG	44	1.9	RB 1 MHz;VB 10 Hz;Peak
7499.990	54.5	V	74.0	-19.5	PK	44	1.9	RB 1 MHz;VB 3 MHz;Peak
7276.530	42.0	V	54.0	-12.0	AVG	315	2.2	RB 1 MHz;VB 10 Hz;Peak
7276.590	51.2	V	74.0	-22.8	PK	315	2.2	RB 1 MHz;VB 3 MHz;Peak
1120.480	50.2	H	N/A	-	Peak	165	1.3	Not radio related
1499.670	58.8	H	N/A	-	Peak	182	1.3	Not radio related
1349.670	50.3	H	N/A	-	Peak	299	1.9	Not radio related



Client:	TiVo, Inc.	Job Number:	J98353
Model:	Minos	T-Log Number:	T98590
		Project Manager:	Irene Rademacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15B and C	Class:	N/A

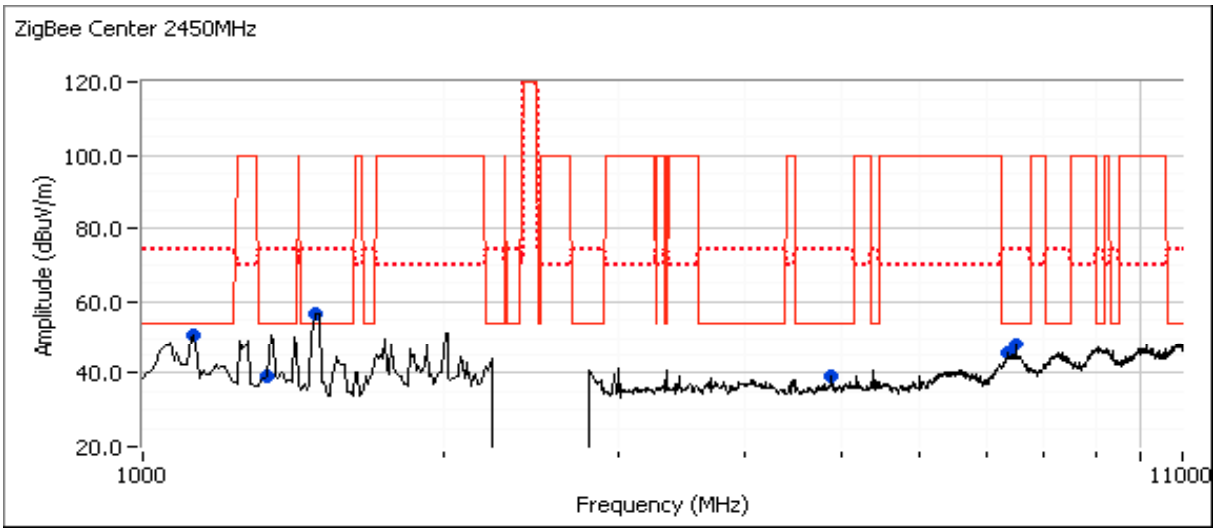


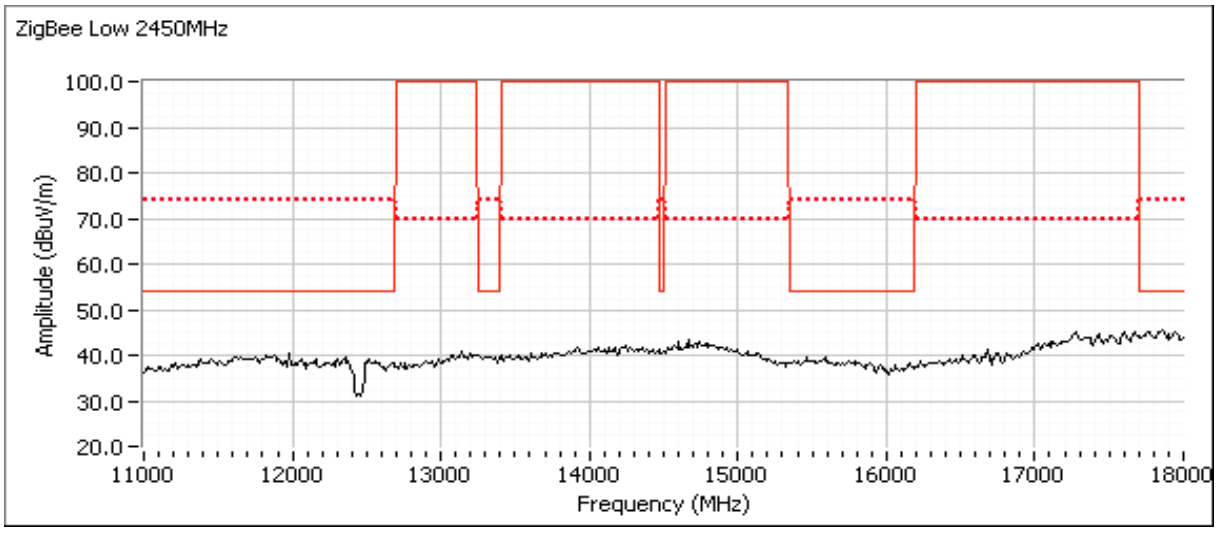


Client:	TiVo, Inc.	Job Number:	J98353
Model:	Minos	T-Log Number:	T98590
		Project Manager:	Irene Rademacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15B and C	Class:	N/A

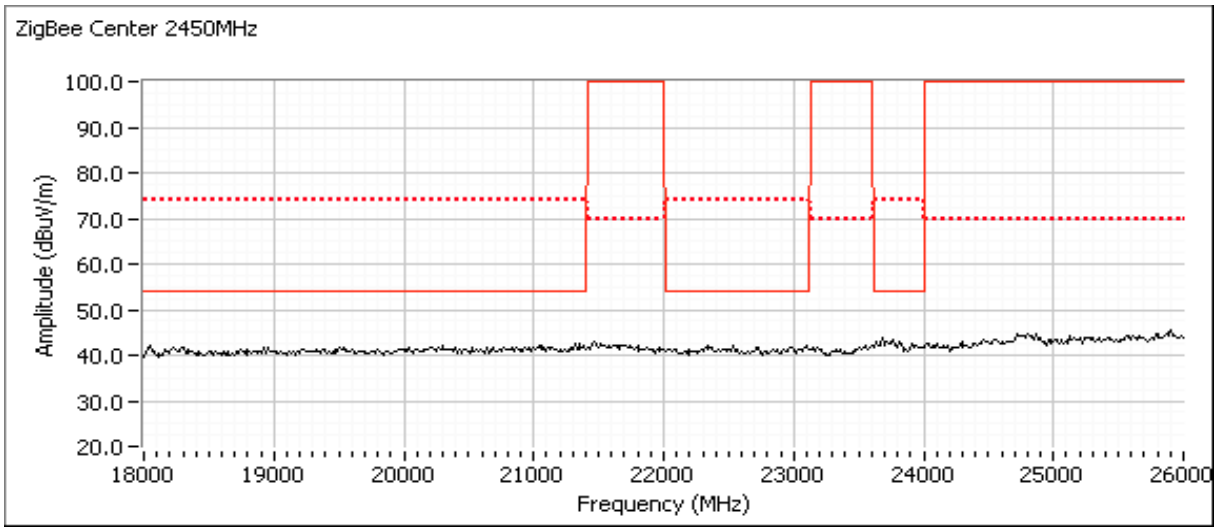
Run #1b: Center Channel @ 2450 MHz

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
7500.050	46.3	V	54.0	-7.7	AVG	20	1.9	RB 1 MHz;VB 10 Hz;Peak
7499.940	53.6	V	74.0	-20.4	PK	20	1.9	RB 1 MHz;VB 3 MHz;Peak
4900.080	34.0	V	54.0	-20.0	AVG	158	1.3	RB 1 MHz;VB 10 Hz;Peak
4900.000	41.7	V	74.0	-32.3	PK	158	1.3	RB 1 MHz;VB 3 MHz;Peak
7348.670	42.9	V	54.0	-11.1	AVG	298	1.6	RB 1 MHz;VB 10 Hz;Peak
7351.830	52.8	V	74.0	-21.2	PK	298	1.6	RB 1 MHz;VB 3 MHz;Peak





Client:	TiVo, Inc.	Job Number:	J98353
Model:	Minos	T-Log Number:	T98590
		Project Manager:	Irene Rademacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15B and C	Class:	N/A

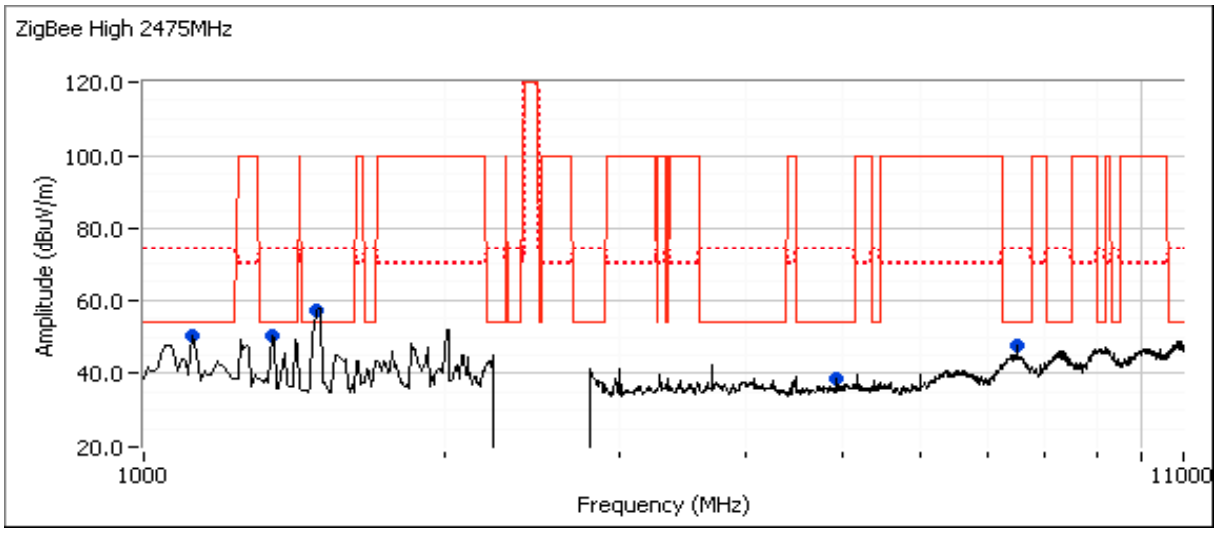


Client:	TiVo, Inc.	Job Number:	J98353
Model:	Minos	T-Log Number:	T98590
		Project Manager:	Irene Rademacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15B and C	Class:	N/A

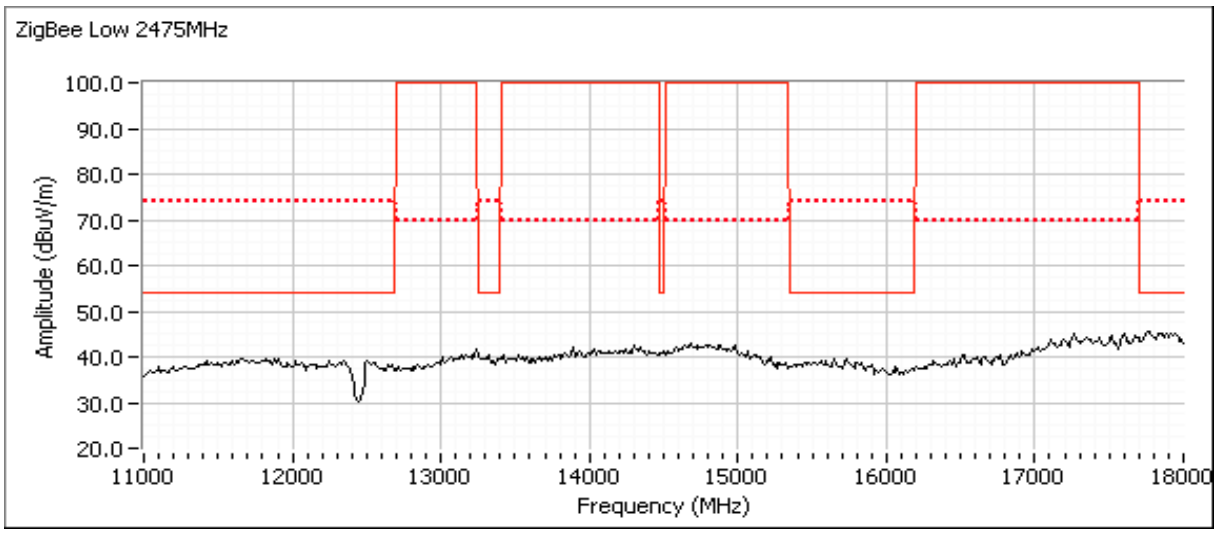
Run #1c: High Channel @ 2475 MHz

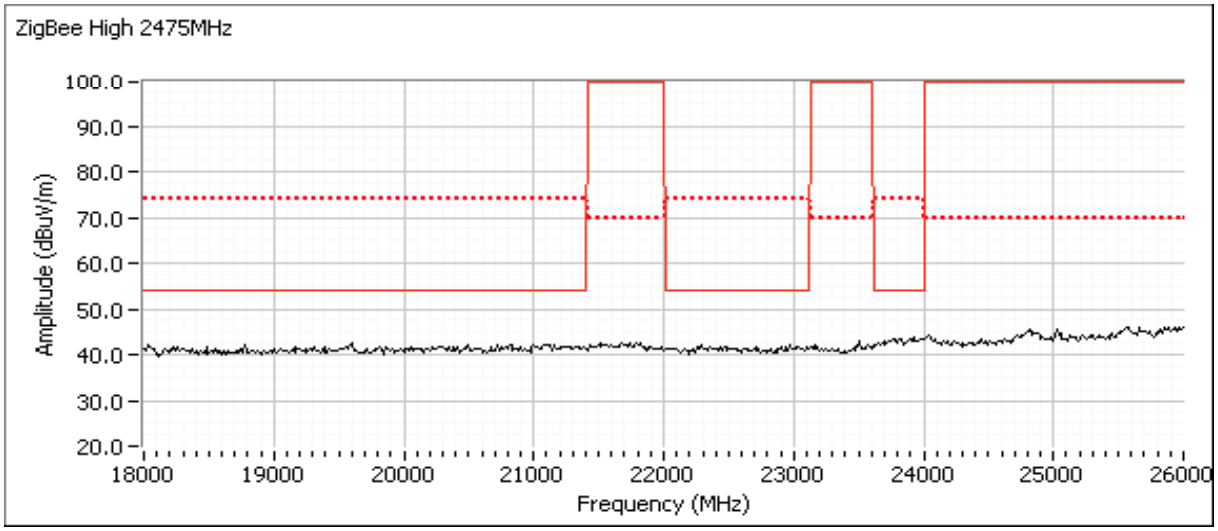
Other Spurious Emissions

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
7500.110	46.6	V	54.0	-7.4	AVG	25	1.6	RB 1 MHz;VB 10 Hz;Peak
7500.090	54.6	V	74.0	-19.4	PK	25	1.6	RB 1 MHz;VB 3 MHz;Peak
4949.990	34.5	V	54.0	-19.5	AVG	116	1.9	RB 1 MHz;VB 10 Hz;Peak
4950.050	42.1	V	74.0	-31.9	PK	116	1.9	RB 1 MHz;VB 3 MHz;Peak
4956.320	38.4	V	54.0	-15.6	Peak	115	1.9	
1120.160	50.3	H	N/A	-	Peak	159	1.9	Not radio related
1493.610	57.1	H	N/A	-	Peak	173	1.3	Not radio related
1349.320	50.3	H	N/A	-	Peak	271	2.5	Not radio related



Client:	TiVo, Inc.	Job Number:	J98353
Model:	Minos	T-Log Number:	T98590
		Project Manager:	Irene Rademacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15B and C	Class:	N/A





Client:	TiVo, Inc.	Job Number:	J98353
Model:	Minos	T-Log Number:	T98590
		Project Manager:	Irene Rademacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15B and C	Class:	N/A

RSS 210 and FCC 15.247 (DTS) Radiated Spurious Emissions

Test Specific Details

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

General Test Configuration

The EUT and all local support equipment were located on the turntable for radiated spurious emissions testing.
For radiated emissions testing the measurement antenna was located 3 meters from the EUT, unless otherwise noted.

Ambient Conditions:

Temperature: 25 °C
Rel. Humidity: 31 %

Summary of Results - Device Operating in the 2400-2483.5 MHz Band

Run #	Mode	Channel	Target Power	Power Setting	Test Performed	Limit	Result / Margin
1	RF4CE	2425MHz	-	Default	Restricted Band Edge (2390 MHz)	FCC Part 15.209 / 15.247(c)	32.0 dBµV/m @ 2350.0 MHz (-22.0 dB)
	RF4CE	2475MHz	-	Default	Restricted Band Edge (2483.5 MHz)	FCC Part 15.209 / 15.247(c)	31.3 dBµV/m @ 2488.6 MHz (-22.7 dB)

Modifications Made During Testing

No modifications were made to the EUT during testing

Deviations From The Standard

No deviations were made from the requirements of the standard.

Sample Notes

Sample S/N: P1-2 76/208
Driver:
Antenna:

Client:	TiVo, Inc.	Job Number:	J98353
Model:	Minos	T-Log Number:	T98590
		Project Manager:	Irene Rademacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15B and C	Class:	N/A

Procedure Comments:

Measurements performed in accordance with FCC KDB 558074
Peak measurements performed with: RBW=1MHz, VBW=3MHz, peak detector, max hold, auto sweep time
Unless otherwise stated/noted, emission has duty cycle ≥ 98% and was measured using RBW=1MHz, VBW=10Hz, peak detector, linear average mode, auto sweep time, max hold.

Mode	Data Rate	Duty Cycle (x)	Constant DC?	T (ms)	Pwr Cor Factor*	Lin Volt Cor Factor**	Min VBW for FS (Hz)
RF4CE	-	1.00	Yes	100	0	0	10

Measurement Specific Notes:

Note 1:	Emission in non-restricted band, but limit of 15.209 used.
Note 2:	Emission in non-restricted band, the limit was set 30dB below the level of the fundamental and measured in 100kHz.
Note 2:	Emission has duty cycle ≥ 98%, average measurement performed: RBW=1MHz, VBW=3MHz, RMS, Power averaging, auto sweep, trace average 100 traces
Note 3:	Emission has duty cycle < 98%, but constant, average measurement performed: RBW=1MHz, VBW=10Hz, peak detector, linear averaging, auto sweep, trace average 100 traces, measurement corrected by Linear Voltage correction factor
Note 4:	Emission has duty cycle < 98% and is NOT constant, average measurement performed: RBW=1MHz, VBW> 1/T, peak detector, linear average mode, sweep time auto, max hold. Max hold for 50*(1/DC) traces
Note 5:	Emission has duty cycle < 98%, but constant, average measurement performed: RBW=1MHz, VBW=3MHz, RMS, Power averaging, auto sweep, trace average 100 traces, measurement corrected by Pwr correction factor
Note 6:	Plots of the average and peak bandedge do not account for any duty cycle correction. Refer to the tabular results for final measurements.

Client:	TiVo, Inc.	Job Number:	J98353
Model:	Minos	T-Log Number:	T98590
		Project Manager:	Irene Rademacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15B and C	Class:	N/A

Run #1: Radiated Bandedge Measurements

Date of Test: 6/10/2015 0:00
Test Engineer: Joseph Cadigal
Test Location: FT Chamber#4

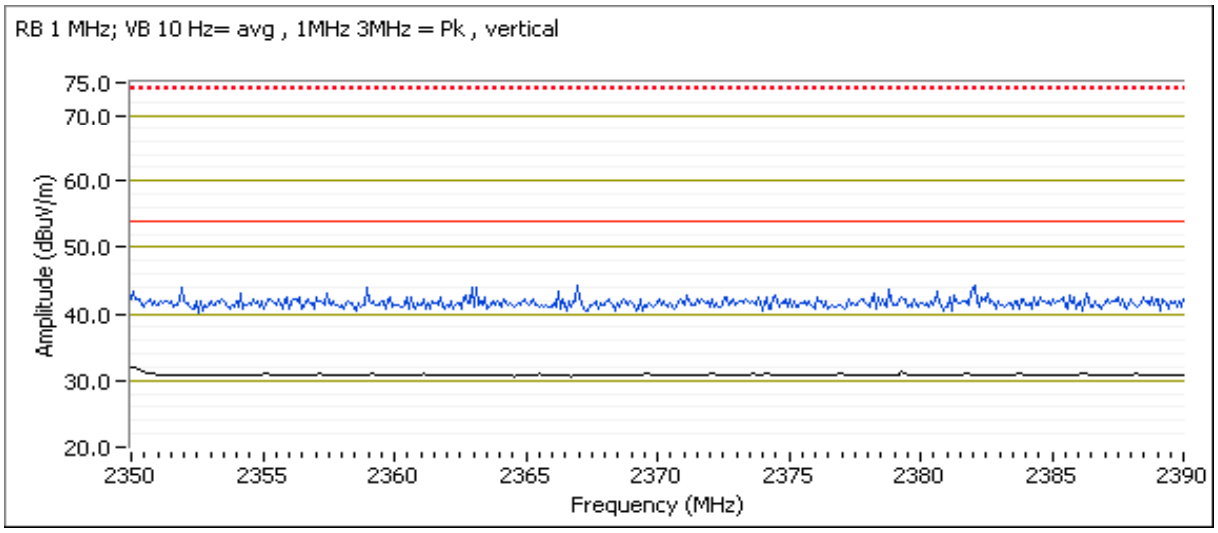
Config. Used: 1
Config Change: none
EUT Voltage: 120V/60Hz

Channel: 2425MHz
Tx Chain: Main

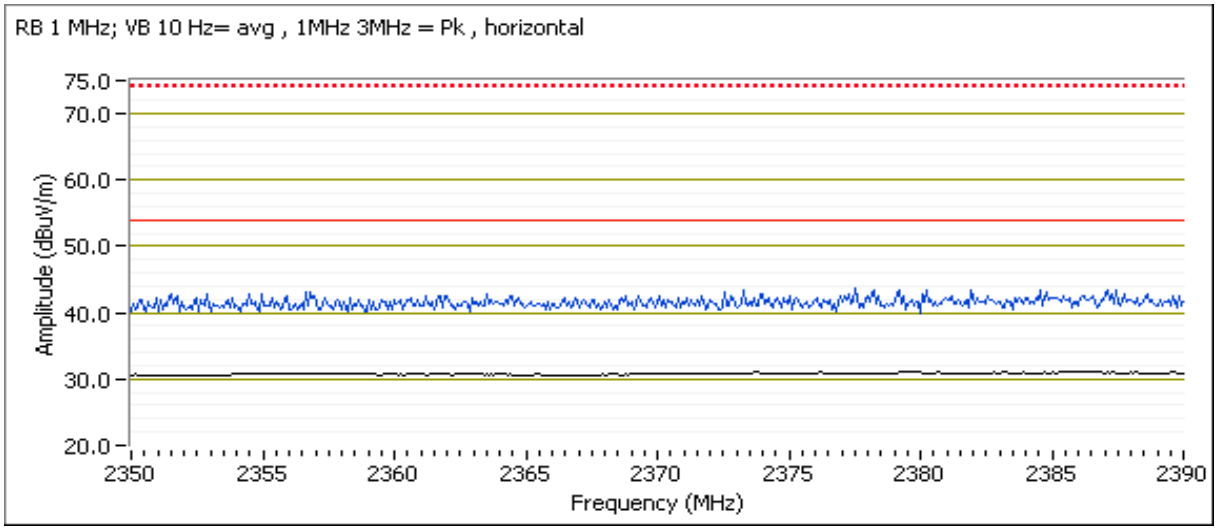
Mode: RF4CE
Data Rate: -

Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2350.000	32.0	V	54.0	-22.0	AVG	227	1.1	POS; RB 1 MHz; VB: 10 Hz
2381.820	42.7	V	74.0	-31.3	PK	227	1.1	POS; RB 1 MHz; VB: 3 MHz
2386.310	31.1	H	54.0	-22.9	AVG	297	1.5	POS; RB 1 MHz; VB: 10 Hz
2352.730	43.2	H	74.0	-30.8	PK	297	1.5	POS; RB 1 MHz; VB: 3 MHz



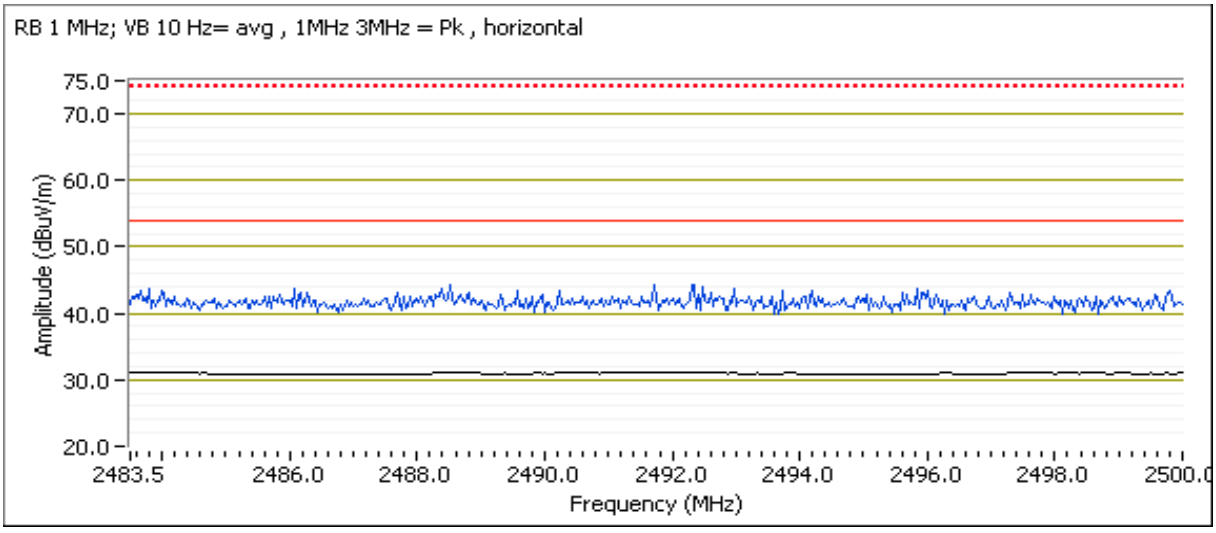
Client:	TiVo, Inc.	Job Number:	J98353
Model:	Minos	T-Log Number:	T98590
		Project Manager:	Irene Rademacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15B and C	Class:	N/A



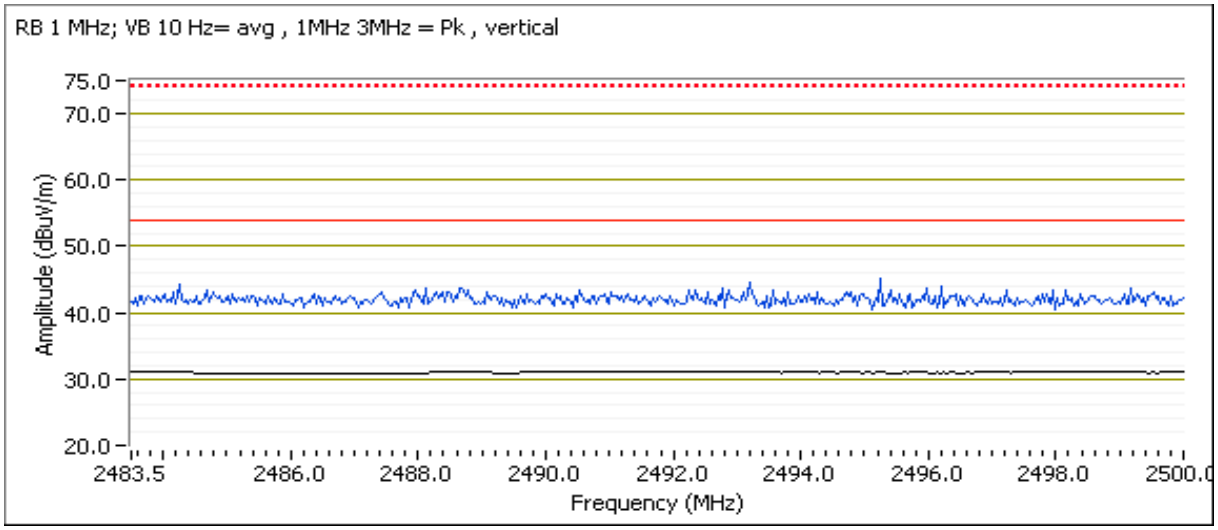
Channel: 2475MHz Mode: RF4CE
Tx Chain: Main Data Rate: -

Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2488.590	31.3	V	54.0	-22.7	AVG	227	1.0	POS; RB 1 MHz; VB: 10 Hz
2493.820	43.7	V	74.0	-30.3	PK	227	1.0	POS; RB 1 MHz; VB: 3 MHz
2483.860	31.2	H	54.0	-22.8	AVG	258	1.1	POS; RB 1 MHz; VB: 10 Hz
2485.250	42.8	H	74.0	-31.2	PK	258	1.1	POS; RB 1 MHz; VB: 3 MHz



Client:	TiVo, Inc.	Job Number:	J98353
Model:	Minos	T-Log Number:	T98590
		Project Manager:	Irene Rademacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15B and C	Class:	N/A



Client:	TiVo, Inc.	Job Number:	J98353
Model:	Minos	T-Log Number:	T98590
		Project Manager:	Irene Rademacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15B and C	Class:	B

Conducted Emissions

(NTS Silicon Valley, Fremont Facility, Semi-Anechoic Chamber)

Test Specific Details

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

Date of Test: 6/10/2015
Test Engineer: Alika Hirano
Test Location: Fremont Chamber #4
Config. Used: 1
Config Change: None
EUT Voltage: 120V/60Hz

General Test Configuration

For tabletop equipment, the EUT was located on a wooden table inside the semi-anechoic chamber, 40 cm from a vertical coupling plane and 80cm from the LISN. A second LISN was used for all local support equipment. Remote support equipment was located outside of the semi-anechoic chamber. Any cables running to remote support equipment where routed through metal conduit and when possible passed through a ferrite clamp upon exiting the chamber.

Ambient Conditions:

Temperature: 22 °C
Rel. Humidity: 37 %

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	CE, AC Power,120V/60Hz	Class B	Pass	55.8 dBµV @ 0.154 MHz (-10.0 dB)

Modifications Made During Testing

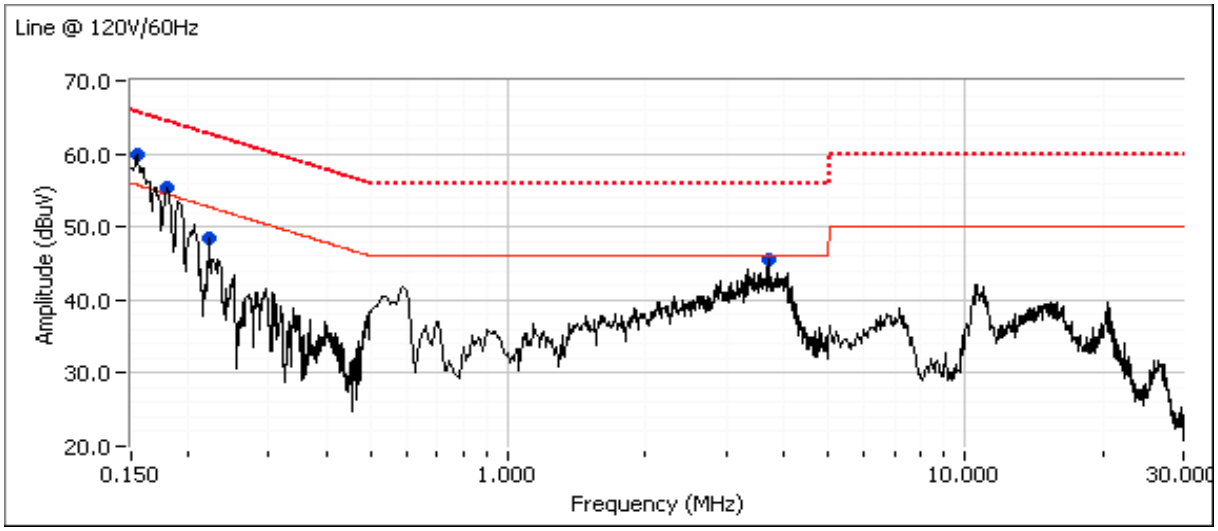
No modifications were made to the EUT during testing

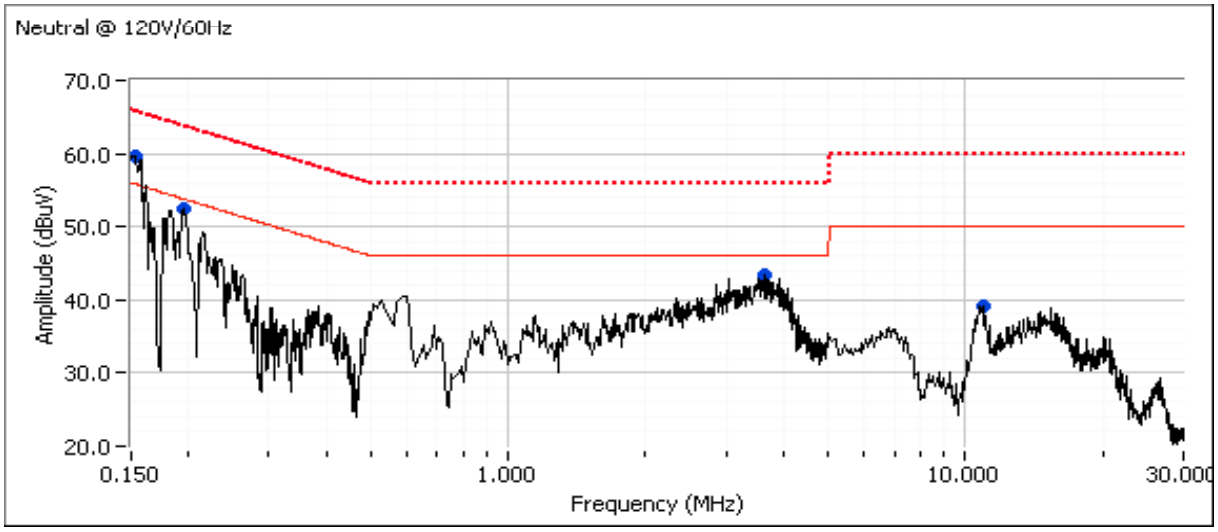
Deviations From The Standard

No deviations were made from the requirements of the standard.

Client:	TiVo, Inc.	Job Number:	J98353
Model:	Minos	T-Log Number:	T98590
		Project Manager:	Irene Rademacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15B and C	Class:	B

Run #1: AC Power Port Conducted Emissions, 0.15 - 30MHz, 120V/60Hz





Client:	TiVo, Inc.	Job Number:	J98353
Model:	Minos	T-Log Number:	T98590
		Project Manager:	Irene Rademacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15B and C	Class:	B

Preliminary peak readings captured during pre-scan (peak readings vs. average limit)

Frequency	Level	AC	Class B		Detector	Comments
MHz	dBµV	Line	Limit	Margin	QP/Ave	
0.154	59.8	Line 1	55.8	4.0	Peak	
0.178	55.3	Line 1	54.5	0.8	Peak	
0.222	48.5	Line 1	52.8	-4.3	Peak	
3.697	45.5	Line 1	46.0	-0.5	Peak	
0.153	59.5	Neutral	55.8	3.7	Peak	
0.194	52.4	Neutral	53.8	-1.4	Peak	
3.625	43.3	Neutral	46.0	-2.7	Peak	
10.919	39.2	Neutral	50.0	-10.8	Peak	

Final quasi-peak and average readings

Frequency	Level	AC	Class B		Detector	Comments
MHz	dBµV	Line	Limit	Margin	QP/Ave	
0.154	55.8	Line 1	65.8	-10.0	QP	QP (1.00s)
0.153	55.3	Neutral	65.8	-10.5	QP	QP (1.00s)
0.178	52.4	Line 1	64.6	-12.2	QP	QP (1.00s)
0.194	49.3	Neutral	63.9	-14.6	QP	QP (1.00s)
3.625	30.0	Neutral	46.0	-16.0	AVG	AVG (0.10s)
0.153	39.1	Neutral	55.8	-16.7	AVG	AVG (0.10s)
3.697	29.2	Line 1	46.0	-16.8	AVG	AVG (0.10s)
3.625	38.3	Neutral	56.0	-17.7	QP	QP (1.00s)
3.697	38.2	Line 1	56.0	-17.8	QP	QP (1.00s)
0.222	44.3	Line 1	62.7	-18.4	QP	QP (1.00s)
0.154	34.6	Line 1	55.8	-21.2	AVG	AVG (0.10s)
0.178	33.4	Line 1	54.6	-21.2	AVG	AVG (0.10s)
10.919	27.3	Neutral	50.0	-22.7	AVG	AVG (0.10s)
0.194	31.0	Neutral	53.9	-22.9	AVG	AVG (0.10s)
10.919	34.3	Neutral	60.0	-25.7	QP	QP (1.00s)
0.222	22.5	Line 1	52.7	-30.2	AVG	AVG (0.10s)

Client:	TiVo, Inc.	Job Number:	J98353
Model:	Minos	T-Log Number:	T98590
		Project Manager:	Irene Rademacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15B and C	Class:	B

Radiated Emissions

(NTS Silicon Valley, Fremont Facility, Semi-Anechoic Chamber)

Test Specific Details

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

Date of Test: 6/17/2015
Test Engineer: Rafael Varelas
Test Location: Fremont Chamber #3
Config. Used: 1
Config Change: None
EUT Voltage: 120V/60Hz

General Test Configuration

The EUT and any local support equipment were located on the turntable for radiated emissions testing. Any remote support equipment was located outside the semi-anechoic chamber. Any cables running to remote support equipment were routed through metal conduit and when possible passed through a ferrite clamp upon exiting the chamber.

The test distance and extrapolation factor (if applicable) are detailed under each run description.

Note, preliminary testing indicates that the emissions were maximized by orientation of the EUT and elevation of the measurement antenna. Maximized testing indicated that the emissions were maximized by orientation of the EUT, elevation of the measurement antenna, and manipulation of the EUT's interface cables.

Ambient Conditions:

Temperature: 21.4 °C
Rel. Humidity: 35 %

Summary of Results (ANSI C63.4:2009)

Run #	Test Performed	Limit	Result	Margin
1	Radiated Emissions 30 - 1000 MHz, Preliminary	Class B	Eval	Refer to individual runs
2	Radiated Emissions 30 - 1000 MHz, Maximized	Class B	Pass	39.8 dBµV/m @ 192.00 MHz (-3.7 dB)

Modifications Made During Testing

No modifications were made to the EUT during testing

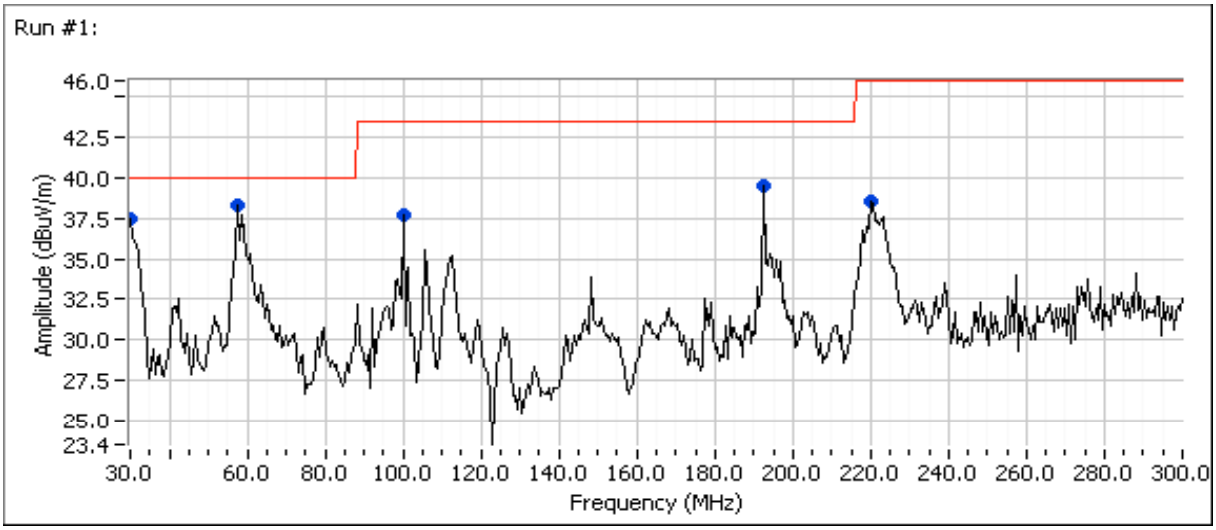
Deviations From The Standard

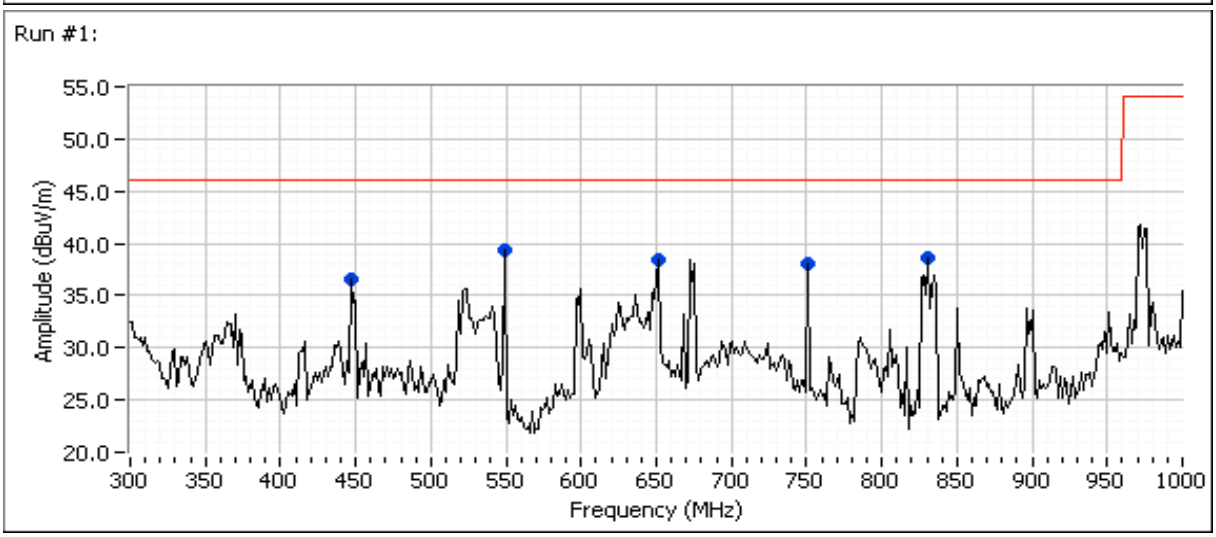
No deviations were made from the requirements of the standard.

Client:	TiVo, Inc.	Job Number:	J98353
Model:	Minos	T-Log Number:	T98590
		Project Manager:	Irene Rademacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15B and C	Class:	B

Run #1: Preliminary Radiated Emissions, 30 - 1000 MHz
EUT transmitting @ 2450 MHz

Test Parameters for Preliminary Scan(s)			
Frequency Range (MHz)	Prescan Distance (meters)	Limit Distance (meters)	Extrapolation Factor (dB, applied to data)
30 - 1000	3	3	0.0





Client:	TiVo, Inc.	Job Number:	J98353
Model:	Minos	T-Log Number:	T98590
		Project Manager:	Irene Rademacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15B and C	Class:	B

Preliminary peak readings captured during pre-scan

Frequency	Level	Pol	Class B		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
30.697	37.5	V	40.0	-2.5	Peak	312	1.0	
58.356	38.3	V	40.0	-1.7	Peak	112	1.5	
100.337	37.7	V	43.5	-5.8	Peak	360	1.5	
192.003	39.5	H	43.5	-4.0	Peak	311	1.5	
221.060	38.5	H	46.0	-7.5	Peak	239	1.5	
450.015	36.5	H	46.0	-9.5	Peak	193	2.0	
550.003	39.4	H	46.0	-6.6	Peak	149	1.5	
650.004	38.4	H	46.0	-7.6	Peak	301	1.5	
750.016	38.0	H	46.0	-8.0	Peak	279	1.0	
829.465	38.6	V	46.0	-7.4	Peak	280	1.0	

Preliminary quasi-peak readings (no manipulation of EUT interface cables)

Frequency	Level	Pol	Class B		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
58.356	35.1	V	40.0	-4.9	QP	115	1.0	QP (1.00s)
550.003	39.8	H	46.0	-6.2	QP	140	1.7	QP (1.00s)
450.015	29.2	H	46.0	-16.8	QP	195	2.0	QP (1.00s)
221.060	35.2	H	46.0	-10.8	QP	239	1.0	QP (1.00s)
750.016	38.3	H	46.0	-7.7	QP	270	1.0	QP (1.00s)
829.465	39.7	V	46.0	-6.3	QP	273	1.1	QP (1.00s)
650.004	36.6	H	46.0	-9.4	QP	314	1.6	QP (1.00s)
192.003	39.8	H	43.5	-3.7	QP	314	1.1	QP (1.00s)
30.697	30.0	V	40.0	-10.0	QP	311	1.0	QP (1.00s)
100.337	32.6	V	43.5	-10.9	QP	360	1.0	QP (1.00s)

Client:	TiVo, Inc.	Job Number:	J98353
Model:	Minos	T-Log Number:	T98590
		Project Manager:	Irene Rademacher
Contact:	Jim Inokuchi	Project Coordinator:	-
Standard:	FCC Part 15B and C	Class:	B

Run #2: Maximized Readings From Run #1

Test Parameters for Maximized Reading(s)			
Frequency Range (MHz)	Test Distance (meters)	Limit Distance (meters)	Extrapolation Factor (dB, applied to data)
30 - 1000	3	3	0.0

Maximized quasi-peak readings (includes manipulation of EUT interface cables)

Frequency	Level	Pol	Class B		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
192.003	39.8	H	43.5	-3.7	QP	314	1.1	QP (1.00s)
58.356	35.1	V	40.0	-4.9	QP	115	1.0	QP (1.00s)
550.003	39.8	H	46.0	-6.2	QP	140	1.7	QP (1.00s)
829.465	39.7	V	46.0	-6.3	QP	273	1.1	QP (1.00s)
750.016	38.3	H	46.0	-7.7	QP	270	1.0	QP (1.00s)
650.004	36.6	H	46.0	-9.4	QP	314	1.6	QP (1.00s)
30.697	30.0	V	40.0	-10.0	QP	311	1.0	QP (1.00s)
221.060	35.2	H	46.0	-10.8	QP	239	1.0	QP (1.00s)
100.337	32.6	V	43.5	-10.9	QP	360	1.0	QP (1.00s)
450.015	29.2	H	46.0	-16.8	QP	195	2.0	QP (1.00s)

End of Report

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